



John Abbot of Georgia

PORTRAIT OF JOHN ABBOT.

From a water-color sketch, said to have been executed by himself, prefixed to one of the series of his paintings of Georgian insects in the British Museum. Copied by George Willis and printed in color from five stones by Julius Bien & Co.

THE
BUTTERFLIES
OF THE
EASTERN UNITED STATES AND CANADA
WITH SPECIAL REFERENCE TO
NEW ENGLAND.

VOL. I.

THE
BUTTERFLIES
OF THE
EASTERN UNITED STATES AND CANADA
WITH SPECIAL REFERENCE TO
NEW ENGLAND.

BY
SAMUEL HUBBARD SCUDDER.

IN THREE VOLUMES.

VOL. I.
INTRODUCTION, NYMPHALIDAE.



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J. B. S.

PREFACE.

THE present work originated in a plan, devised thirty years ago by the students of Professor Louis Agassiz, to describe within the compass of a series of volumes all the animals of New England, with special reference to their life histories. To me was assigned, among other subjects, the volume on Lepidoptera, and though the original scheme never passed beyond the stage of discussion (and the design of a titlepage by one of our number, which I still preserve), it has borne fruit in not a few additions to our knowledge of "The Zoölogy of New England," by my associates, — Messrs. Allen, Hyatt, Morse, Packard, Putnam, Shaler, and Verrill, to mention the living only. Twenty years ago the present work was definitely planned, announced, and begun, and the greater part of it has been written for fifteen years; but with the increase of our knowledge, nearly all the histories of the species have been completely rewritten within the past few years, in the intervals of work in other directions.

This delay has not been to follow the sage advice of Horace, —

"Si quid tamen olim
Scripseris, in Mæci descendat indicis auris,
Et patris et nostras, nonumque prematur in annum,
Membranis intus positis : " ¹

but has been caused rather by the "res angusta domi," preventing earlier accomplishment of my desire.

Although very much more extended than I at first contemplated, especially in the matter of illustration, the work as completed is still far short of what I could wish; insufficient attention, for instance, has been paid to the differences in the form and clothing of the head in the various stages of the caterpillar, though the illustrations of the same will partly atone for this omission. I had also intended to include a description of the minute texture of the integument of the caterpillar, and made many preparations for the purpose, but not enough to warrant the introduction of this material.

It had also been my purpose to make extended comparisons of the species described with their nearest allies outside the region concerned, together with critical discussions, when necessary, to explain the synonymy

¹ Ars Poëtica, 386.

employed; regarding these points, on reflection, as more suitable to a monographic treatment of the special groups themselves, I have generally omitted them to make room for what seemed more fitting and more commonly neglected. So too it had been my purpose to reinforce the descriptions of the male abdominal appendages (prepared while in Europe) by a study of these parts during life; but the purpose had finally to be abandoned in all but a very few instances. But, as it stands, it is, I believe, the most exhaustive faunistic work on any insects of any part of the world. Whether its completeness has interfered with its exactitude, or will prevent a proper comprehension of relations; whether the work is of too encyclopedic a nature, or is warranted in the present state of science, time only will show. If I have made my descriptions fuller than usual, it is because I do not think our aim should be simply to inquire in what particulars a creature differs from its fellows, but rather to ascertain all we can about each sort of animal, its most intimate structure and clothing, to serve as the basis of the most secure generalizations. Such descriptions may seem unnecessary to those whose only aim is the discrimination of species; they will, I hope, prove of some value to those who seek a knowledge of species. I have in all endeavored to look to the future rather than to the past; to keep in their just proportions structure, growth, life history, environment, distribution, and taxonomy, that neither should say to its neighbor, "I have no need of thee."

Special emphasis has been laid on the proper subordination of characters, a matter grievously neglected by the ordinary student of butterflies, who, more than any other virtuoso, it seems to me, shows the lack of that training which fits men to be zoölogists rather than entomologists, — entomologists rather than lepidopterists. Particular attention and just criticism is therefore invited to the use that has been made of the early stages of the insect, — egg, caterpillar at birth and at maturity, and chrysalis, — in the definition of the various categories of structure among butterflies, whether families, subfamilies, tribes, or genera. This is a feature never before attempted on any scale at all commensurate with that found here; and though the characteristics have very largely been drawn from a limited fauna, such survey as has been made of the fields beyond warrants the belief that these definitions will not require correction except in minor details or to a slight degree. That a first attempt of this sort will prove to some extent faulty goes without saying. That the old warning cry of "insufficient knowledge" should longer stay endeavor, ought to be a reproach to the naturalist, for herein lies the most hopeful field of progress, and it is to the credit of American naturalists that with them, more than anywhere in the world, attention is paid to the early stages and life histories of insects. To give precision, harmony, and direction to such investigations has been one aim of this work.

There can, indeed, be no doubt that the principal weakness in those structures which naturalists have built and called the classification of but-

terflies is due not so much to insufficient knowledge of their early stages as to insufficient attention to what is actually known and published regarding them. The principal modifications in that structure must now come from a consideration of the earlier stages; and though Denis and Schiffermüller, in their classical work on Vienna Lepidoptera, long ago wrote, "Ein Aug auf dem Schmetterling, das andere auf die Raupen, so werden alle Schwierigkeiten gehoben," it may fairly be doubted whether one in ten of those who, in the century that has elapsed since that was said, have discussed the classification of butterflies, have ever made the slightest examination of the newly-born caterpillar of a single butterfly, or could tell in what points it differed from its own self at maturity. Yet no biologist will dispute that the study of these earliest forms is at least of equal importance to the study of the mature caterpillar for any correct knowledge of the phylogeny—and hence the classification—of butterflies. It is only the closet naturalist, with whom the world is now done, that would hesitate. The painful fact nevertheless remains that one may count on his two hands the names of those in all the world who have ever contributed to a knowledge of the structural characteristics of butterfly caterpillars at birth.

It will be thought by many that some justification is needed for the course adopted in subdividing the different groups more minutely than is customary. To such I have only to say that if the characters I have pointed out as pertaining to such groups and their relations to those placed above and below them are not in themselves a justification, then I have none, and no words of mine could or should alter such a fact; if, however, these characteristics represent actual categories, and if at the same time such groupings make clearer the relations which the life histories and the distribution of the groups bear to their structure, then words are not needed.

On the other hand, I may be permitted to ask one question of such complainants. If this minute subdivision did not affect the commonly adopted scientific names of butterflies (as it does in many instances), would any objection be raised or any justification be required? If no objection would be raised (and who believes there would?), then is all this outcry against "fine-drawn distinctions" a mere quarrel about words and names, into which, as quite too trivial, I decline to enter. Call things by what names one will, I only ask that the facts of nature be rightly interpreted; and where differences are found, that they be given their proper values as nearly as we can determine them, absolutely regardless of the effect it is to have upon the paltry question of names. Names can never have absolute fixity until we have absolute knowledge of all the facts regarding the creatures they represent, and the sooner this truth is recognized the better for all concerned.

I, for one, do not stand with those who claim that all our classifications are mere conveniences, momentary artificial strait-jackets for a redundant and irrepressible Nature. In so far as they do not represent

Nature, they are artificial; but they, and not Nature, become thereby inconvenient. In so far as they do represent Nature, are they natural, the expressions of natural facts, and so, convenient and valuable. We gauge their value and their convenience by the closeness of their harmony with Nature; or, if we do not, then are our opinions worthless; but let us not suppose that Nature has yet revealed all her secrets, nor that she will reveal them except to the earnest and devout inquirer.

As to the nomenclature actually adopted, I have endeavored to follow the rules laid down by the American Ornithologists' Union; for, though they contravene my views of what would be best at very many points, they seem to me, in the existing divergence of views on this subject, by far the best yet proposed which are likely to receive final adoption by all. The progressive adhesion to their principles by men holding very diverse opinions makes one hopeful of such a peaceful result.

I had planned originally to introduce poetical allusions to butterflies here and there; but the chance collection of these citations showed them to be so much more numerous than I had supposed, that, with the aid of several friends, I searched literature for its entomological specimens, and the collection at last became so extensive as to serve for even more than a relief from the dry synonymy they followed, and to permit here and there a selection which had some special significance. An examination of the list of authors cited, which includes about one hundred and fifty names, will quickly show how much more generally the poets of our modern world have received their inspiration from the external life of Nature than have the earlier poets.

The butterflies treated of in the Appendix were introduced into the work when it was seen that the fauna of New England required but little extension to have it include all the butterflies known to occur in North America east of the Mississippi, excepting such as are found only in the unsettled parts of Canada or south of Kentucky and Virginia. It was, however, an afterthought not entering into the original plan, and could not be made so complete in the important matters of the history and distribution of the species without delaying the work for the collection of material; it has indeed been written during the printing of the work. To maintain a better balance, I have therefore limited also the descriptive portion, added such notes as were readily procurable, though I have doubtless overlooked some important matter, and have separated the species from the body of the work, thereby warranting the running title at the head of the earlier pages.

A few explanatory words may be added regarding some details. In the synonymy of the species I have given only what seemed essential, omitting much that had been collected, with a view of presenting the first mention of the insect under each of the names that had been given it, and adding to that only the more important citations, including especially original descriptions of the early stages and accounts of life histories, and

all original illustrations; and also two other kinds of references, — first, all manuals in common use, such as those of Morris, Fernald, and French; and second, references to the unpublished illustrations of Abbot and of Glover. As regards the common names, I have only to refer to *Excursus XXV*. The measurements of the butterflies have been made on the following plan for each sex separately: Choice was made at the time of the description, when the largest possible number of specimens were collected, of the largest and smallest individuals based on a measurement of their spread of wing; an average specimen of what was deemed the ordinary size was then selected by the eye, and all measurements were based on these three individuals. This will account for the occasional lacunae which were never filled by measurements from different individuals.

There remains only the pleasing task of thanking those without whose generous and welcome aid my work would have been shorn of half its value. From the moment of its announcement, years ago, assistance has been offered from a hundred sources, from persons in all walks of life, many of them then entirely unknown to me, who sent notes and specimens of the greatest importance, especially of the early stages of our butterflies; so much so, that at one time it was difficult to pursue the systematic outdoor studies I intended, so constant was the flow of needed material. The memory of those first beginnings of the work will always be fresh in my mind, and in particular the kind assistance of Miss Clarissa Guild and Messrs. J. B. Hambly, W. Saunders, C. A. Emery, J. A. Lintner, C. E. Hamlin, and F. A. Clapp, who were constant in their transmission of specimens. Since then, most important material of the same sort has been received from Judge Chapman of Florida, Dr. Riley of Washington (both of these with abundant notes), Messrs. H. Edwards of New York, and F. G. Sanborn, F. H. Sprague, and G. Dimmock, of Massachusetts, besides Misses Soule and Eliot and Mr. S. Lowell Elliot. If I have not in connection with this mentioned Mr. W. H. Edwards, it is only because I wish to make special acknowledgment of repeated and constant favors through a score of years in the gift and loan of specimens, and the use of drawings. Without his aid the book would be far more incomplete. Then, there are many from whom I have received hardly less important favors, including longer or shorter lists of captures with their seasons, which have been of great importance to me, the loan or gift of specimens for description, illustration, or dissection. I do not know whether, in the lapse of time since some were received, I can now recall them all, but I set down their names as they chance to occur to me, and among them will be recognized many a known entomologist: Messrs. J. G. Jack, Holmes Hinckley, E. L. Morton, Roland Thaxter, Samuel Henshaw, Roland Hayward, P. S. Sprague and son, James Angus, N. H. Bishop, L. Trouvelot (who painted also many of the insects), C. S. Minot, Profs. William Cook, A. E. Verrill, Sanborn Tenney, Messrs. J. G. Shute, N. C. Greene, E. B. Reed, H. Gillman, W. V. Andrews, H. H. Ballou, C. P. Whitney, A. B. Foster, Profs. A. S. Packard, E. L. Mark,

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Acknowledgments are given upon the plates, or the explanations accompanying them, for many favors from friends, which need not be repeated here; but I owe a special debt of gratitude to Mr. Edward Burgess for his kind aid in drawing for me the abdominal appendages of our butterflies, and in most cases of making the dissections himself at great expense of time and pains; and my acknowledgments are due to Mrs. Todd, of Amherst, for her permission to let me copy her painting of New England flowers and butterflies, which has been used for the temporary cover to the parts during the issue of the work.

Finally, I have warmly to thank my colleagues, Profs. Wm. M. Davis and S. W. Williston, Messrs. L. O. Howard, C. V. Riley, and Charles W. Woodworth, and the writer of the Excursus on p. 1257, who have consented to prepare chapters upon subjects related to my work, but with which I was not sufficiently familiar to do them justice,—chapters which have added in no small degree to its value. It should however be distinctly stated that these writers, and particularly Messrs. Howard, Riley, and Williston, are in no way responsible for the terminology of the butterflies mentioned in their respective sections. The names are there employed as they would have been had the chapters been written by myself.

S. H. SCUDDER.

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TABLE OF CONTENTS.

Vol. I.

	PAGE
PREFACE	vii
LIST OF ILLUSTRATIONS	xxiii
INTRODUCTION. — I. THE GENERAL STRUCTURE OF BUTTERFLIES	1
The Egg	2
The Larva or Caterpillar	8
The Pupa or Chrysalis	27
The Imago or Butterfly	36
II. THE MODERN CLASSIFICATION OF BUTTERFLIES HISTORICALLY CONSIDERED	52
III. THE PHYSICAL FEATURES AND FAUNISTIC DIVISIONS OF NEW ENGLAND	75
THE PHYSICAL GEOGRAPHY OF NEW ENGLAND. By W. M. DAVIS	75
THE CLIMATE OF NEW ENGLAND. By W. M. DAVIS	86
THE ZOÖLOGICAL DIVISIONS OF NEW ENGLAND	89
IV. STUDIES ON THE EMBRYOLOGICAL DEVELOPMENT OF EUVANESSA ANTIOPA.	
By C. W. WOODWORTH	95
KEY TO THE FAMILIES OF BUTTERFLIES	105
FAMILY NYMPHALIDAE	109
Subfamily Satyrinae	115
Genus Oeneis	123
EXCURSUS I. <i>The White Mountains of New Hampshire as a Home for Butterflies</i> . .	127
Oeneis semidea	134
Oeneis jutta	149
Genus Cercyonis	156
EXCURSUS II. <i>The Clothing of Caterpillars</i>	161
Cercyonis alope	163
Cercyonis nephele	171
Genus Enodia	175
EXCURSUS III. <i>The General Changes in a Butterfly's Life and Form</i>	178
Enodia portlandia	180

	PAGE
Genus <i>Satyrodes</i>	187
EXCURSUS IV. <i>The Eggs of Butterflies</i>	190
<i>Satyrodes eurydice</i>	193
Genus <i>Neonympha</i>	199
EXCURSUS V. <i>The Modes of Suspension of Chrysalids</i>	201
<i>Neonympha phocion</i>	203
Genus <i>Cissia</i>	203
EXCURSUS VI. <i>The Geographical Distribution of Butterflies</i>	211
<i>Cissia eurytus</i>	214
Subfamily Nymphalinae	222
Tribe <i>Apaturidi</i>	223
Genus <i>Chlorippe</i>	231
EXCURSUS VII. <i>The Ancestry of Butterflies; the Primæval Form</i>	235
<i>Chlorippe clyton</i>	241
Tribe <i>Nymphalidi</i>	249
Genus <i>Basilarchia</i>	250
EXCURSUS VIII. <i>The Means employed by Butterflies of the Genus Basilarchia for the Perpetuation of the Species</i>	260
<i>Basilarchia archippus</i>	267
<i>Basilarchia astyanax</i>	280
<i>Basilarchia proserpina (astyanax-arthemis)</i>	289
<i>Basilarchia arthemis</i>	294
Tribe <i>Vanessidi</i>	306
Genus <i>Polygonia</i>	309
EXCURSUS IX. <i>Dimorphism and Polymorphism</i>	316
<i>Polygonia interrogationis</i>	319
<i>Polygonia comma</i>	332
<i>Polygonia satyrus</i>	344
<i>Polygonia faunus</i>	348
<i>Polygonia gracilis</i>	359
<i>Polygonia progne</i>	362
Genus <i>Eugonia</i>	372
EXCURSUS X. <i>Butterflies at Night and at Sea; out of Season and out of Place</i>	376
<i>Eugonia j-album</i>	379
Genus <i>Eu Vanessa</i>	387
EXCURSUS XI. <i>Butterfly Sounds</i>	392
<i>Eu Vanessa antiopa</i>	397
Genus <i>Aglais</i>	413
EXCURSUS XII. <i>How Butterflies winter</i>	418
<i>Aglais milberti</i>	420
Genus <i>Vanessa</i>	430
EXCURSUS XIII. <i>Butterflies common to the Old and the New World; where did they originate?</i>	436

TABLE OF CONTENTS.

XV

	PAGE
Vanessa atalanta	441
Vanessa huntera	457
Vanessa cardui	469
Genus Junonia	487
EXCURSUS XIV. <i>The Ways of Butterflies</i>	491
Junonia coenia	494
Tribe Argynnidi	502
Genus Euptoieta	506
EXCURSUS XV. <i>The Origin and Development of Ornamentation in Butterflies</i>	510
Euptoieta claudia	519
Genus Speyeria	528
EXCURSUS XVI. <i>Antigeny; or Sexual Diversity in Butterflies</i>	531
Speyeria idalia	535
Genus Argynnis	545
EXCURSUS XVII. <i>Lethargy in Caterpillars</i>	551
Argynnis cybele	554
Argynnis aphrodite	563
Argynnis atlantis	571
Genus Brenthis	578
EXCURSUS XVIII. <i>Glacial Reminders; Our Oldest New England Butterflies</i>	588
Brenthis myrina	593
Brenthis montinus	601
Brenthis bellona	608
Tribe Melitaeidi	618
Genus Phyciodes	621
EXCURSUS XIX. <i>The Butterfly Fauna of the Eastern United States, and especially of New England, compared to that of Europe</i>	625
Phyciodes tharos	629
Phyciodes batesii	643
Genus Charidryas	647
EXCURSUS XX. <i>The Three Pioneer Students of Butterflies in this Country</i>	651
Charidryas nycteis	658
Genus Cinclidia	667
EXCURSUS XXI. <i>Companionship and Commensalism among Caterpillars</i>	671
Cinclidia harrisii	674
Genus Euphydryas	684
EXCURSUS XXII. <i>The Hibernation of Caterpillars</i>	688
Euphydryas phaeton	690

	PAGE
Subfamily Euploeinae	703
Genus Anosia	705
EXCURSUS XXIII. <i>Mimicry and Protective Resemblance; or, Butterflies in Disguise</i>	710
Anosia plexippus	720
Subfamily Libytheinae	749
Genus Hypatus	753
EXCURSUS XXIV. <i>Fossil Butterflies</i>	756
Hypatus bachmanii	760

VOL. II.

FAMILY LYCAENIDAE	767
Subfamily Lemoniinae	772
Genus Calephelis	783
EXCURSUS XXV. <i>The Names of Butterflies</i>	785
Calephelis borealis	788
Subfamily Lycaeninae	791
Tribe Theclidi	798
Genus Strymon	802
EXCURSUS XXVI. <i>Hypermetamorphosis in Butterflies</i>	804
Strymon titus	809
Genus Erora	815
EXCURSUS XXVII. <i>The Best Localities for Collectors; Favorite Butterfly Haunts</i>	817
Erora laeta	819
Genus Incisalia	823
EXCURSUS XXVIII. <i>Habit as a Guide in Classification</i>	826
Incisalia niphon	829
Incisalia irus	834
Incisalia angustus	842
Genus Uranotes	846
EXCURSUS XXIX. <i>The Procession of the Seasons</i>	849
Uranotes melinus	850
Genus Mitura	856
EXCURSUS XXX. <i>The Adornment of Caterpillars</i>	859
Mitura damon	861

	PAGE
Genus <i>Thecla</i>	868
EXCURSUS XXXI. <i>Sexual Diversity in Legs, Wings, and Scale Arrangement</i> . . .	872
<i>Thecla ontario</i>	875
<i>Thecla liparops</i>	877
<i>Thecla calanus</i>	885
<i>Thecla edwardsii</i>	892
<i>Thecla acadica</i>	898
Tribe <i>Lycaenidi</i>	902
Genus <i>Everes</i>	905
EXCURSUS XXXII. <i>Length of Life in Butterflies</i>	909
<i>Everes comyntas</i>	911
Genus <i>Cyaniris</i>	918
EXCURSUS XXXIII. <i>Digoneutism in Butterflies; Intensity of Life in America</i> . .	923
<i>Cyaniris pseudargiolus</i>	927
Genus <i>Nomiades</i>	948
EXCURSUS XXXIV. <i>Origin of Varieties in Butterflies, Possible and Probable</i> . .	950
<i>Nomiades couperi</i>	953
Genus <i>Rusticus</i>	957
EXCURSUS XXXV. <i>The Friends and Associates of Caterpillars</i>	962
<i>Rusticus scudderii</i>	964
Tribe <i>Chrysophanidi</i>	970
Genus <i>Chrysophanus</i>	972
EXCURSUS XXXVI. <i>The Distribution of Butterflies in New England</i>	975
<i>Chrysophanus thoe</i>	977
Genus <i>Epidemia</i>	982
EXCURSUS XXXVII. <i>Local Butterflies</i>	984
<i>Epidemia epixanthe</i>	985
Genus <i>Heodes</i>	990
EXCURSUS XXXVIII. <i>Psychological Peculiarities in our Butterflies</i>	995
<i>Heodes hypophlaeas</i>	998
Genus <i>Feniseca</i>	1009
EXCURSUS XXXIX. <i>Periodicity in the Appearance of Butterflies</i>	1014
<i>Feniseca tarquinius</i>	1016
FAMILY PAPILIONIDAE	1027
Subfamily <i>Pierinae</i>	1033
Tribe <i>Rhodoceridi</i>	1040
Genus <i>Callidryas</i>	1043
EXCURSUS XL. <i>Aromatic Butterflies</i>	1047
<i>Callidryas eubule</i>	1053

	PAGE
Genus <i>Xanthidia</i>	1061
EXCURSUS XLI. <i>The Colonization of New England</i>	1064
<i>Xanthidia nicippe</i>	1066
Genus <i>Eurema</i>	1073
EXCURSUS XLII. <i>The Swarming and Migrations of Butterflies</i>	1077
<i>Eurema lisa</i>	1087
Genus <i>Eurymus</i>	1096
EXCURSUS XLIII. <i>Color Preferences of Butterflies; the Origin of Color in Butterflies</i>	1101
<i>Eurymus interior</i>	1105
<i>Eurymus philodice</i>	1111
<i>Eurymus eurytheme</i>	1126
Tribe <i>Anthocharidi</i>	1137
Genus <i>Anthocharis</i>	1139
EXCURSUS XLIV. <i>Protective Coloring in Caterpillars</i>	1143
<i>Anthocharis genutia</i>	1147
Tribe <i>Pieridi</i>	1154
Genus <i>Pontia</i>	1156
EXCURSUS XLV. <i>Cosmopolitan Butterflies</i>	1160
<i>Pontia protodice</i>	1163
Genus <i>Pieris</i>	1171
EXCURSUS XLVI. <i>The Spread of a Butterfly in a new Region</i> (with a map)	1175
<i>Pieris oleracea</i>	1191
<i>Pieris rapae</i>	1205
Subfamily <i>Papilioninae</i>	1219
Genus <i>Laertias</i>	1230
EXCURSUS XLVII. <i>A Study of Certain Caterpillars</i>	1234
<i>Laertias philenor</i>	1241
Genus <i>Iphiclides</i>	1252
EXCURSUS XLVIII. <i>The Butterfly in Ancient Literature and Art.</i> By C. H. B.	1257
<i>Iphiclides ajax</i>	1264
Genus <i>Jasoniades</i>	1280
EXCURSUS XLIX. <i>Melanism and Albinism</i>	1285
<i>Jasoniades glaucus</i>	1288
Genus <i>Euphœades</i>	1305
EXCURSUS L. <i>Deceptive Devices among Caterpillars; or, the Defences of Caterpillars</i>	1310
<i>Euphœades troilus</i>	1313
Genus <i>Heraclides</i>	1327
EXCURSUS LI. <i>Southern Invaders</i>	1332
<i>Heraclides crespontes</i>	1334

	PAGE
Genus Papilio	1345
EXCURSUS LII. <i>The Law of Suffusion in Butterflies</i>	1350
Papilio polyxenes	1353
FAMILY HESPERIDAE	1365
Tribe Hesperidi	1373
Genus Eudamus	1378
EXCURSUS LIII. <i>Effect of Cold on Development</i>	1383
Eudamus proteus	1386
Genus Epargyreus	1393
EXCURSUS LIV. <i>Odd Caterpillars</i>	1397
Epargyreus tityrus	1399
Genus Achalarus	1412
EXCURSUS LV. <i>Variations in Habit and in Life according to Locality and Season</i> <i>of the Year</i>	1415
Achalarus lycidas	1418
Genus Thorybes	1423
EXCURSUS LVI. <i>Some Singular Things about Caterpillars</i>	1427
Thorybes bathyllus	1432
Thorybes pylades	1436
Genus Thanaos	1445
EXCURSUS LVII. <i>Nests and other Structures made by Caterpillars</i>	1454
Thanaos lucilius	1458
Thanaos persius	1468
Thanaos juvenalis	1476
Thanaos horatius	1486
Thanaos terentius	1490
Thanaos martialis	1493
Thanaos ausonius	1498
Thanaos brizo	1500
Thanaos icelus	1507
Genus Pholisora	1514
EXCURSUS LVIII. <i>The Perils of the Egg</i>	1518
Pholisora catullus	1519
Genus Hesperia	1527
EXCURSUS LIX. <i>Anomalies in Geographical Distribution</i>	1531
Hesperia montivaga	1536
Hesperia centaureae	1542
Tribe Pamphilidi	1546
Genus Ancyloxipha	1551
EXCURSUS LX. <i>A Budget of Curious Facts about Chrysalids</i>	1554
Ancyloxipha numitor	1558

	PAGE
Genus Pamphila	1563
EXCURSUS LXI. <i>What Families of Plants are preferred by Caterpillars?</i>	1567
Pamphila mandan	1569
Genus Amblyscirtes	1575
EXCURSUS LXII. <i>Color Relations of Chrysalids to their Surroundings</i>	1578
Amblyscirtes vialis	1582
Amblyscirtes samoset	1589
Genus Poanes	1592
EXCURSUS LXIII. <i>Butterflies as Botanists</i>	1594
Poanes massasoit	1597
Genus Phycanassa	1600
EXCURSUS LXIV. <i>Postures at rest and asleep</i>	1602
Phycanassa viator	1604
Genus Atrytone	1607
EXCURSUS LXV. <i>The Enemies of Butterflies</i>	1610
Atrytone logan	1614
Atrytone zabulon	1617
Genus Hylephila	1625
EXCURSUS LXVI. <i>Seasonal Dimorphism</i>	1627
Hylephila phylaeus	1630
Genus Erynnis	1634
EXCURSUS LXVII. <i>The Costal Fold and Discal Streak of Skippers</i>	1639
Erynnis sassacus	1641
Erynnis manitoba	1646
Erynnis metea	1650
Erynnis attalus	1653
Genus Atalopedes	1656
EXCURSUS LXVIII. <i>Flight in Butterflies</i>	1659
Atalopedes huron	1661
Genus Anthomaster	1667
EXCURSUS LXIX. <i>Butterfly Vision</i>	1669
Anthomaster leonardus	1673
Genus Polites	1678
EXCURSUS LXX. <i>Sexual Diversity in the Form of the Scales</i>	1681
Polites peckius	1683
Genus Thymelicus	1689
EXCURSUS LXXI. <i>The Act of Pupation</i>	1693
Thymelicus aetna	1696
Thymelicus brettus	1701
Thymelicus mystic	1705

TABLE OF CONTENTS.

xxi

	PAGE
Genus Limochores	1711
EXCURSUS LXXII. <i>The Laws of Colorational Pattern</i>	1715
Limochores bimacula	1718
Limochores manataaqua	1720
Limochores taumas	1725
Limochores pontiac	1732
Genus Euphyes	1735
EXCURSUS LXXIII. <i>How Butterflies suck</i>	1737
Euphyes metacomet	1739
Euphyes verna	1742
Genus Calpodes	1746
EXCURSUS LXXIV. <i>Odd Chrysalids</i>	1749
Calpodes ethlius	1750
Genus Oligoria	1757
EXCURSUS LXXV. <i>Monstrosities</i>	1759
Oligoria maculata	1761
Genus Lerema	1763
EXCURSUS LXXVI. <i>The Coloring of Butterflies as related to their Distribution</i>	1766
Lerema accius	1768
Lerema hianna	1771

VOL. III.

BUTTERFLIES OF THE NORTHEASTERN UNITED STATES AND CANADA,
NOT FOUND IN NEW ENGLAND.

NYMPHALIDAE.		LYCAENIDAE.		Nathalis iole 1842	
Oeneis macounii	1775	Callicista columella . .	1820	Synchlœ olympia . . .	1844
Oeneis calais	1777	Calycopis cecrops . . .	1821	Euphœades palamedes .	1844
Cereyonis pegala . . .	1779	Thecla lorata	1823	Papilio brevicauda . .	1851
Coenonympha inornata	1782	Eupsyche m-album . .	1824		
Neonympha cornelius .	1783	Atlides halesus . . .	1827	HESPERIDAE.	
Neonympha mitchellii .	1785	Nomiades lygdanmus .	1828	Rhabdoides cellus . .	1855
Cissia sosybius	1786	Rusticus striatus . . .	1829	Thorybes electra . . .	1856
Chlorippe celtis	1788	Epidemia dorcas . . .	1830	Pholisora hayhurstii .	1857
Anaea andria	1794			Oarisma powesheik . .	1859
Semnopsyche diana . .	1799			Potanthus omaha . . .	1861
Argynnis alcestis . . .	1802	PAPILIONIDAE.		Erynnis uncas	1862
Brenthis freija	1805	Callidryas sennae . . .	1831	Limochores palatka . .	1863
Brenthis chariclea . .	1808	Callidryas philea . . .	1833	Euphyes osyka	1865
Charidryas ismeria . .	1810	Zerene cesonia	1836	Prenes ocola	1866
Agraulis vanillae . . .	1814	Pyrisitia mexicana . .	1840	Prenes panoquin . . .	1867

THE HYMENOPTEROUS PARASITES OF NORTH AMERICAN BUTTERFLIES.

By L. O. HOWARD, with a section on the Microgasterinae by C. V. RILEY.

ICHNEUMONIDAE.		CHALCIDIDAE.		PROCTOTRUPIDAE.	
<i>Ichnumon rufiventris</i> . . .	1875	<i>Chalcis flavipes</i> . . .	1886	<i>Telenomus graptae</i> . . .	1896
“ <i>caliginosus</i> . . .	1876	<i>Chalcis robusta</i> . . .	1887	<i>Telenomus rileyi</i> . . .	1896
“ <i>instabilis</i> . . .	1876	<i>Encyrtus montinus</i> . . .	1887		
“ <i>versabilis</i> . . .	1877	<i>Copidosoma turni</i> . . .	1888	BRACONIDAE.	
<i>Hoplismenus morulus</i> . . .	1878	<i>Pteromalus chionobae</i> . . .	1889	Microgasterinae.	
<i>Trogus exesorius</i> . . .	1878	“ <i>puparum</i> . . .	1890	<i>Apanteles glomeratus</i> . . .	1898
<i>Trogus obsidianator</i> . . .	1879	“ <i>vanessae</i> . . .	1890	“ <i>congregatus</i> . . .	1901
<i>Hemiteles utilis</i> . . .	1879	“ <i>archippi</i> . . .	1891	“ <i>edwardsii</i> . . .	1901
<i>Hemiteles lycaenae</i> . . .	1880	<i>Derostenus antiopae</i> . . .	1891	“ <i>megathymi</i> . . .	1902
<i>Cryptus</i> sp.	1880	<i>Cirrospilus niger</i> . . .	1892	“ <i>limenitidis</i> . . .	1902
<i>Ophion bilineatus</i> . . .	1880	<i>Tetrastichus semideae</i> . . .	1893	“ <i>lunatus</i> . . .	1903
<i>Exochilum mundum</i> . . .	1881	“ <i>saundersii</i> . . .	1893	“ <i>cyaniridis</i> . . .	1903
<i>Anomalus pseudargioli</i> . . .	1881	“ <i>thecae</i> . . .	1893	“ <i>argynnidis</i> . . .	1904
<i>Mesochorus pieridiculus</i> . . .	1882	“ <i>modestus</i> . . .	1894	“ <i>koebelae</i> . . .	1904
<i>Mesochorus scitulus</i> . . .	1882	<i>Trichogramma minu-</i>		“ <i>flavicornis</i> . . .	1905
<i>Limneria fugitiva</i> . . .	1883	<i>tum</i>	1894	“ <i>emarginatus</i> . . .	1906
<i>Limneria limenitidis</i> . . .	1883	<i>Trichogramma minutis-</i>		“ <i>thecae</i> . . .	1906
<i>Pimpla annulipes</i> . . .	1884	<i>simum</i>	1895	“ <i>junoniae</i> . . .	1907
<i>Glypta erratica</i>	1885	<i>Trichogramma interme-</i>		“ <i>carduicola</i> . . .	1907
		<i>dium</i>	1895	“ <i>atalantae</i> . . .	1908
BRACONIDAE.				“ <i>pholisorae</i> . . .	1909
<i>Microdus sanctus</i> . . .	1886			“ <i>cassianus</i> . . .	1909
				<i>Microgaster carinata</i> . . .	1910

THE DIPTEROUS PARASITES OF NORTH AMERICAN BUTTERFLIES.

By S. W. WILLISTON.

<i>Acroglossa hesperidarum</i>	1917	<i>Exorista theclarum</i>	. . . 1920	<i>Phorocera comstocki</i>	. . . 1922
<i>Exorista futilis</i>	. . . 1917	<i>Exorista scudderii</i>	. . . 1921	<i>Masicera archippivora</i>	. . . 1923
" <i>blanda</i>	. . . 1918	<i>Phorocera edwardsii</i>	. . . 1921	" <i>frenchii</i>	. . . 1923
" <i>hirsuta</i>	. . . 1919	<i>Phorocera saundersii</i>	. . . 1922	" <i>rileyi</i>	. . . 1924

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LIST OF ILLUSTRATIONS.

VOL. I.

PORTRAIT OF JOHN ABBOT *Frontispiece.*

VOL. II.

PORTRAIT OF JOHN LeCONTE *Frontispiece.*

	PAGE
A SERIES OF FIGURES SHOWING THE CHANGES DURING PUPATION IN ANTHO- CHARIS GENUTIA. (Lent by Mr. W. H. Edwards.)	1152
MAP SHOWING THE PROGRESSIVE DISTRIBUTION OF PIERIS RAPAE IN AMERICA BETWEEN 1860 AND 1886 (folded)	<i>Opposite page</i> 1188
A SERIES OF FIGURES ILLUSTRATING THE CONSTRUCTION OF THE MEDIAN GIRTH IN THE PUPATION OF EUPHOEADES TROILUS. (By Dr. C. V. Riley.) . . .	1324
A SERIES OF FIGURES ILLUSTRATING THE MODE OF FIXATION OF THE CREMASTER OF THE CHRYSALIS IN THE PAD CONSTRUCTED BY THE CATERPILLAR OF DIFFERENT BUTTERFLIES. (By Dr. C. V. Riley.)	1694

VOL. III.

PORTRAIT OF THADDEUS WILLIAM HARRIS	<i>Frontispiece.</i>
BUTTERFLIES IN COLOR	<i>Plates</i> 1-10
BUTTERFLIES IN BLACK	" 11-17
COLORING MAPS OF GEOGRAPHICAL DISTRIBUTION	" 18-32
MALE ABDOMINAL APPENDAGES	" 33-37
NEURATION OF THE WINGS	" 38-42
SCALE PATCHES AND FOLDS OF THE WING MEMBRANE FOUND IN THE MALE BUTTERFLY	" 43-45
ANDROCONIA, OR SCALES PECULIAR TO THE MALE SEX	" 46-51

SIDE VIEWS OF BUTTERFLIES, SHOWING APPENDAGES OF THE HEAD AND	
THORAX (excepting the wings)	<i>Plates 52-60</i>
MISCELLANEOUS STRUCTURAL DETAILS OF THE IMAGO	<i>Plate 61</i>
INTERNAL ANATOMY OF ANOSIA PLEXIPPUS	" 62
EMBRYOLOGY OF EUVANESSA ANTIOPA (in color)	" 63
EGGS IN COLOR AND IN BLACK	<i>Plates 64-66</i>
MICROPYLES OF EGGS	" 67-69
CATERPILLARS AT BIRTH (much enlarged)	" 70-73
MATURE CATERPILLARS (mostly in color)	" 74-77
HEADS OF CATERPILLARS AT DIFFERENT STAGES	" 78-80
NESTS OF CATERPILLARS	" 81, 82
CHRYSLIDS IN COLOR AND IN OUTLINE	" 83-85
MISCELLANEOUS STRUCTURAL DETAILS, MOSTLY OF THE EARLY STAGES	" 86, 87
HYMENOPTEROUS AND DIPTEROUS PARASITES	" 88, 89
PHYSICAL MAP OF NEW ENGLAND (in color, folded)	<i>At end.</i>
ISOTHERMAL AND FAUNAL MAP OF NEW ENGLAND (in color, folded)	<i>At end.</i>
MAP OF THE WHITE MOUNTAINS OF NEW HAMPSHIRE (in color)	<i>At end.</i>

THE BUTTERFLIES OF NEW ENGLAND.

INTRODUCTION.

I.

THE GENERAL STRUCTURE OF BUTTERFLIES.

Repent? Not I. Repentance is the weight
Of indigested meals eat yesterday.
'Tis for large animals that gorge on prey,
Not for a honey-sipping butterfly.
I am a thing of rhyme and redondillas,
The momentary rainbow on the spray
Made by the thundering torrent of men's lives:
No matter whether I am here or there;
I still catch sunbeams.

GEORGE ELIOT.—*The Spanish Gypsy.*

THE word butterfly is a popular term for a few of the higher families of scaly-winged insects, or Lepidoptera. Although for many years systematic writers have frequently used the terms Papilionidae, Rhopalocera, Globulicornes or Acalinoptera with similar signification, the group is not a natural one, — that is, as an assemblage of lepidopterous insects, it has no equivalents of equal value and weight. The grouping is simply a convenience, not the expression of a natural division. The four families of scaly-winged insects which are thus assembled may, however, be usually distinguished in their perfect state from the other families by the thickening of the tips of their antennae, so as to make the latter appear more or less clubbed; also by the total absence of any lateral appendages to the separate antennal joints; and by the want of a bristle-like extension of the costal nervure of the hind wings, by which it is caught to the front pair, — all which features obtain in the majority of other Lepidoptera. They differ also, but in a very general way only, in habits, butterflies usually holding their wings erect when not in use, almost invariably flying only by day, and in their transformations seldom spinning any cocoon, the hinder end of the chrysalis being provided with little hooks by which a firm hold is had of a button of silk spun beforehand to cling to; while other Lepidoptera generally fly

by night, expand their wings fully or even incline them downwards when at rest, pass their chrysalis state in a cocoon or beneath the ground, and have no hooks at the tip of the chrysalis; all these features, however, are liable to frequent exceptions.

Together with all other lepidopterous insects, the butterfly is well known to undergo peculiar and, to outward appearance, very sudden transformations during its growth; born as an egg, it emerges from it as a worm-like animal called a caterpillar, which feeds voraciously on the plant upon which the maternal instinct has taught the butterfly to lay her egg, casts its skin several times in its growth, and finally, sloughing its integument again, comes out a pupa or chrysalis, in which the creature appears as if in swaddling clothes, all its appendages neatly encased upon its breast, and itself helpless and almost completely motionless, — to ordinary view as different as possible from the aerial creature with variegated tremulous wings one may see shortly afterward sipping honey from an open flower, or dancing merrily in the sunlight.

Changes similar to these are now known to occur throughout no inconsiderable portion of the animal kingdom, but they are most familiar to the popular mind and were first known to the ancients in the insect tribes and, *par excellence* in the Lepidoptera.

Without entering in full upon the characteristics of lepidopterous insects in general, we shall in this introduction first examine the general structure of butterflies both external and internal, in the various stages of existence, as a basis for a knowledge of their proper classification. We shall next outline such a classification by means of a historical survey of former endeavors; follow this by a study of the physical features of the territory with whose butterflies and butterfly faunas we have most to do, and close with a special investigation of the earliest beginnings of life within the eggs of butterflies. We shall then be prepared to discuss the different sorts in systematic detail.

THE EGG.

All insects, likewise, bring forth worms, except a certain genus of butterflies, and these bring forth a hard substance resembling a grain of bastard saffron, but which internally is liquid.

ARISTOTLE, *Taylor's translation*.

External characteristics (PLATES 64-69).

The eggs of butterflies are composed externally of a thin pellicle, separable into the base, walls and micropyle; the first is usually flat, destitute of special markings, serving simply as a field of attachment; the walls are variously sculptured and compose the rest of the egg, excepting the minute micropyle, which occupies the very summit, and is made up of a rosette of excessively minute cells.

These eggs, though always circular or roundly polyhedral* in section, vary greatly in shape, and are classed in one of the chapters of this work into barrel-shaped, globular, tiarate and hemispherical. The first are the most common, vary much in proportionate height and are usually also ribbed vertically, the ribs varying in our species from eight to thirty or forty in number, the former obtaining in some species of *Vanessidi*, the latter in *Eurema*. Where the ribs run from base to summit, the space between them is always broken up into quadrate cells, by much more frequent and generally more delicate raised transverse lines. But the character of the ribs varies in different species almost as much as the form of the egg itself; and while some of these eggs are two and a half times higher than broad, the height of others exceeds their breadth by very little; some are thimble-shaped, sugar loaf-, flask- or acorn-shaped, while others are even fusiform; so the ribs may either be coarse and heavy, or delicate, strongly compressed and greatly elevated; they may be as large at their edges as at their bases, or wedge-shaped; the cross lines are usually very delicate, but in a few species they vie with the vertical ribs in stoutness and near or upon the summit of the egg are often much heavier than elsewhere. Barrel-shaped eggs occur in every family excepting the *Lycaenidae*.

Globular eggs occur only in the *Satyrinae*, *Nymphalidi*, and *Papilioninae*. They are always a little flattened at the base. The surface is either simply rugose, as in the *Papilioninae*; or covered with very minute and very inconspicuous cells, as in some *Satyrinae*; or is broken up, as in *Nymphalidi*, by very high and thin partition-walls into pretty regular deep hexagonal cells, from the angles of which thread-like filaments project to a considerable distance.

Hemispherical eggs are only known in the *Pamphilidi*, and among them we find great uniformity. The surface, apparently smooth, is broken up by exceedingly delicate lines into minute, usually hexagonal cells, the floor of which is profusely filled with shallow microscopic punctulations.

With the sole exception of the genus *Parnassius* among *Papilionidae*, not found in eastern America, tiarate or echinoid eggs are confined to and include all of the *Lycaenidae*, but in one genus, *Heodes*, the base of the egg is broadened to such an extent that it is only by sufferance that it can be classed here; it is rather demiechinoid; the surface of tiarate eggs is nearly always broken up into cells of varying size separated by distinct heavy walls, which are sometimes of uniform height throughout, at others produced at the angles into tubercles presenting on close examination a very different effect.

The egg shell, without taking into account the increased thickness which is often given to a large part of the surface by ridges and ribs, is always

*Doherty says that in the East Indian *Lycaenid*, *Poritia*, the egg is hexahedral, which

probably means simply that the cells are excessively large and few.

moderately heavy and tough. It seems to be thinnest in the *Vanessidi*, but the presence of high thin ribs prevents one from readily examining through the shell the nature of the contents or the condition of the embryo. In the *Pamphilidi*, it is unusually thick and at the same time opaque, while in some of the *Lycaenidae*, the walls of the cells are sometimes excessively heavy, especially on the crown of the egg.

The centre of the summit is always occupied by the micropyle (Plates (67-69), a system of delicate microscopic canals, usually from four to six in number, which radiate from a minute pit in the very centre, and the mission of which is to convey into the egg spermatie threads for its fertilization. Around these is a rosette of minute cells, the character of which in the *Pamphilidi* differs but little from ordinary cell structure excepting in its delicacy. In nearly all butterflies it occupies an inconsiderable portion of the summit of the egg and in some species is either so minute or obscure as with difficulty to be seen at all, excepting under the most favorable light. Usually it is slightly depressed, and in some cases is situated at the bottom of a profound pit, but in others the contour of the shell is not disturbed by its presence. The cells generally increase in size from the centre outward, and, although sometimes comparatively few in number and arranged, especially the central ones, in a definite pattern, are more commonly crowded rather confusedly together.

Internal changes, as seen externally.

Having been unable to improve my opportunities of studying the embryology of butterflies, and almost nothing being known concerning the changes they undergo within the egg, I am forced to content myself here with bringing forward the following brief statements concerning such phenomena as may be witnessed through the usually rather opaque shell. This I the less regret as I have obtained the kind cooperation of Dr. Woodworth, whose special study of the embryological history of *Euvanessa antiopa* will appear in the closing section of this Introduction.

The changes which transpire within the eggs of butterflies, as viewed through the external envelope, may be said to indicate rudely four distinct stages of development; all of these stages, excepting perhaps the last at its close, are often greatly or entirely obscured from view, either by the opacity of the shell itself, as in some of the *Pamphilidi*, or by the confusion arising from the rough sculpturing of the outer surface, as in the *Lycaeninae*, *Basilarchia*, *Pieris* and the *Argynnidi*, and even to some extent in the more delicately marked *Vanessidi*.

In the *first period* the contents are homogeneous, just as when they are laid, when only a pure color, shining through the integument, can be seen; this condition lasts but a short time,—doubtless much shorter than appears from the indications which can penetrate the shell; a certain change makes

its appearance in from two to four days after deposition, or in from one-third to one-seventh of the total duration of the embryonic life. In *Eurymus philodice* a change was first noticed in forty two hours after deposition, so that the first stage occupied about one third of its life. In *Cercyonis alope* no difference was noted until the third or fourth day or after one seventh of its oval existence had elapsed.

The first change of color proclaims the advent of the *second period*, in which a uniform alteration is noticed in every part of the contents of the egg, — probably the period known to embryologists as that in which the formation of the blastoderm or cellular layer takes place; it is indicated externally either by a uniform dotting of the whole surface with specks of a deeper, usually reddish, color giving to the egg a new tint; or by a simple change of color, its cause being obscure. In *Cercyonis alope* for example, the color changes from honey yellow to a pale pink color; in *Euphydryas phaeton* (64:37)* the original yellow becomes strongly tinged with brown; in *Eurymus philodice* the yellow yields to a pale salmon; in *Limochores taumas* the change is from pale green to a pale wood-brown tinged with green; in the last case a closer inspection shows this alteration to be accompanied by the appearance of deep vinous flecks scattered over the whole egg; sometimes these are reduced to mere dots, at others they are larger, while ill-defined streaks are distributed over the surface with great irregularity and no apparent meaning. This period is of even shorter duration than the preceding. In *Eurymus philodice* it lasts but fourteen hours; in *Limochores taumas* four or five days; but the usual term is one or two days. In *Ancyloxypha numitor*, the first two stages occupy two days and a half.

The *third period* is first indicated by a decided and significant change in the distribution of the spots or of the tints. Either there is simply a distinction between the poles, or more commonly, an aggregation of the flecks into larger more or less irregular spots, forming a narrower or broader band around the middle of the egg, at equal distances from the base. During this period, which doubtless corresponds to the formation of the germinal band, the organs and parts of the future caterpillar, whether they are in their primordial condition or have assumed the contour and divisions of the growing insect, lie wholly in an annulus upon the same plane with the base of the egg; this seems almost impossible in the elongated fusiform egg of *Eurymus philodice*, but I see no reason, from the observations I have made, to believe that this embryo departs in any way from the general law. This period is generally longer than any of the others, occupying in nearly all the species I have observed fully one half of their embryonic life; in *Limochores taumas*, however, it occupies but two or three days of the twelve or thirteen usually passed in the egg. In *Euphydryas phaeton* the

* Black faced numerals refer to the plate; others to the figures on the plate.

accession of this stage is marked by an alteration of the previously uniform brown to a brown which is of a rich purplish hue above and dark yellowish below, a change which seems to increase in intensity as growth advances. In all other observed species, the change is somewhat different. In *Eurymus philodice* the uniform salmon is exchanged for a broad central band of bright reddish orange, the opposite poles being yellow. In *Ancyloxypha numitor* (66:35) irregular ragged patches of deep orange red make their appearance, encircling the egg with an archipelago of color. In *Limochores taumas* the change is indicated, first by an alteration in the position of the reddish flecks which now congregate in the upper half of the egg,—a change which seems analogous to that referred to in *Euphydryas phaeton*; then by their collecting into streaks similar to those of *Ancyloxypha numitor*, running irregularly in every direction; and finally by their still greater concentration into a broad spot, such as will next be described in *Erynnis metea*. In this latter species the opacity of the shell does not permit the earlier stages to be witnessed and the first indication we have of any change is the appearance of an obscure fuscous band or cloud across one side of the egg, extending from the extreme base a little way over the summit, its edges full and rounded; afterward it contracts, occupying only the middle of the side.

There are then indications of at least three successive stages in this period, viz., the polarity of the contents, the appearance of a central annulus and the definition of a large lateral spot; the first two correspond to the formation of the primitive band and the last to the definite construction of the head. The duration of the first stage seems to be shorter than that of the two succeeding ones, which are about equal in length.

The Papilioninae, owing to the greater tenuity of the shell, offer better opportunities for the examination of the contents of their eggs than the Hesperidae. I have not, however, taken special note of their earlier life. In both *Papilio polyxenes* and *Euphœades troilus* the flecks and streaks are dark green and reddish brown, and in the latter portion of this period assume a definite arrangement, sketching in a vague way the contour of the enclosed larva, whose coil is visible from the summit of the egg; the dermal appendages seem to be formed at an earlier period than we should anticipate, and through means of them the parts can be more readily recognized; in this instance, as I believe in all others, the colored flecks are more clearly indicated on the side of the larva nearest the summit of the egg and appear as little papillae or tongues, often spatulate in form, projecting from the body and so overlapping each other as to form an intricate net-work. At this time, the close of the third period, the half-formed larva lies in a coil around the egg-shell, reclining upon its side, its head and hinder extremity in juxtaposition and in the same plane.

The change to the *fourth* and final period is a very short one, and in

this period the larva attains its embryonic maturity by exceedingly rapid growth; the eireuit of the egg no longer suffices for its more extended body and the head gradually moves a little upwards and inwards, the lower portions of the anterior segments slide over the upper portions of the posterior ones and the head occupies the centre of the summit of the structure; in this position the larva is to be found just before emerging.

Twenty-four hours before hatching, the egg of *Euphroeades troilus* shows the beginning of this stage; the mandibles of the larva may then be plainly seen, hanging separated from each other like ordinary appendages, while the head is just beginning to twist inwards; subsequently the animal is so coiled in the egg that the middle line of the mandibles (their serrated edges rolling over each other like cog-wheels) lies directly over the suture which separates the fourth and fifth segments of the abdomen; the thoracic segments are so bent as to bring the head against the abdominal rings, the apex of the triangle on the front of the head lying just at or slightly in advance of the summit of the egg, the hairs of the subdorsal abdominal series are directed toward and interlap those of the opposite sides, excepting on the two terminal segments where they are directed posteriorly. All this growth is effected in a single day, during which the larva frequently changes its position by twirling in the shell, a movement probably produced by the aid of the dermal appendages of the body; these, as I shall hereafter show, are peculiar to this stage of the insect's life, being lost, not indeed at the exit from the egg-envelope, but at the first moulting of the larva.

In *Erynnis metea*, *Limochores taumas*, and doubtless all the other *Pamphilidi*, where the third period is marked by a lateral blotch, the change from the third to the fourth period is indicated by a removal of this patch to the summit of the egg and the appearance within it of a darker smaller spot,—the mandibles. In *Erynnis metea* this patch occupies the whole of the upper third of one side of the egg and the upper half of the other side; the darker spot included in it is transverse and reniform and occurs on that side where the patch is largest, a little above the middle of the egg. In *Eurymus philodice* the change is indicated by the assumption of a plumbeous hue and in *Euphydryas phaeton* by a growing paleness at the base and of dinginess at the summit of the egg. In nearly all these instances the change occurs within a day of hatching, but in those butterflies which remain a long while in the egg state (excluding of course those which hibernate, and which have not been brought at all under consideration), this period may last for two or three days. In butterflies which I have studied the duration of the egg-state in the summer varies from five to twenty-seven days.

THE LARVA OR CATERPILLAR.

Born, bred, with just one instinct,—that of growth;
 Her quality was, caterpillar-like,
 To all-unnerringly select a leaf
 And without intermission feed her fill,
 Become the Painted Peacock, or belike
 The Brimstone-wing, when time of year should suit;
 And 'tis a sign (say entomologists)
 Of sickness, when the creature stops its meal
 One minute, either to look up at heaven,
 Or turn aside for change of aliment.

BROWNING.—*Red Cotton Night-Cap Country.*

External form and characters.

Caterpillars of butterflies differ in no single feature from those of moths. In general, they may be said to be long, cylindrical and uniform, usually more or less flattened beneath, and to be composed of two regions, perfectly distinct from each other.—a head and a body; the former is a horny, compact, more or less appressed, globular case bearing numerous appendages about the oral orifice; the body is divided into thirteen nearly equal fleshy segments, the anterior three of which form the future thorax, bearing each a pair of more or less horny five-jointed legs, armed at tip with a simple claw; the others, which form the future abdomen, being provided on the third to the sixth and the last segments with a pair of stout fleshy prolegs or stumps, bearing at the tip a series of minute hooks; all the segments of the body are provided with hairs, tubercles, spines or filaments, and some with lateral openings,—the spiracles or breathing pores.

The head and its appendages (87:16). The head is divided by a suture into two lateral halves, but near the middle of the front this suture divides and leaves between its forks a triangular space, the frontal triangle or clypeus, which is often characteristically marked: it is down this middle suture that the head splits when the integument is cast for pupation; at previous exuviations the head is cast entire, but at the final moult the two halves are parted; just within and parallel to this forked suture, forming the lateral walls of the frontal triangle, is another more deeply impressed line, which would readily be taken for the suture, since the markings are distributed in relation to this rather than to the other; it is, however, simply the reverse of an interior ridge for the support of muscles; the true suture is almost always very inconspicuous and can often hardly be discovered in the earlier larval stages (78-80). The two can best be seen in *Anosia*. Just below the triangle and as broad as its base is a very short piece, generally inconspicuous and welded to the triangle, most distinct in the *Papilioninae*, called the epistoma, to the lower edge of which the labrum is attached; the latter is usually bilobed by a very deep excision of its front border, generally narrower than the epistoma, to which it is attached by a fleshy hinge, is always broader than long and moves freely back and forth

upon the mandibles, the upper base of which it serves to protect. The mandibles, one on either side, are composed each of a short, very stout, tumid, horny plate, broadening from the base apically, its apical edge more dense, and either straight and chisel-like or somewhat serrated, the teeth usually triangular (86:32). Behind the mandibles lies the basal portion of the maxillae,—a fleshy mass bearing a large but short and somewhat mammiiform joint; this in its turn bears an inner and an outer palpus; the inner is ordinarily much the less conspicuous, and consists of only one or two joints, which generally resemble, but are smaller than, the penultimate or the apical two joints of the outer palpus; the latter usually consists of three joints, the apical two at least being of a partially horny consistency, each of them cylindrical, equal, and usually much smaller than the preceding, the last being always minute and frequently almost imperceptible. These two palpi are crowded together just at the base of the mandibles. Occupying nearly the whole of the remaining portion of the under surface of the head between the basal portions of the opposing maxillae, is the labium; its basal portion resembles that of the maxillae; it bears apically on either side, just within the inner base of the maxillary palpi, a pair of minute, slender, two jointed labial palpi, the basal joint of which is comparatively long, the apical very minute; between these two the apex of the labium is peculiarly developed, being tumid and bearing on a swollen base a small, conical, slender, depending, horny tube, forming the spinneret, through an orifice in which the fluids pass when the insect spins silk. The antennae, lying just outside the base of the mandibles, are composed of four joints; the basal joint large, fleshy, mammiiform, pressed upon by the base of the widely expanded jaws; the second much smaller, usually half as long as broad, and having a somewhat horny consistency; the third slenderer than the second, much, sometimes thrice, longer than broad, cylindrical, nearly equal, abruptly truncate and bearing at its tip a very long tapering bristle, usually much longer than the rest of the antenna; beside this bristle, but not in the middle, is situated an exceedingly minute fourth joint, sometimes difficult to distinguish. The ocelli (86:24,25) are situated just behind and a little above the base of the antennae. They generally have the appearance of smooth hemispherical warts, some larger than others and occasionally somewhat protuberant, six in number in most mature caterpillars, of which five are generally arranged in a more or less open and regular curve, whose convexity is forward and whose anterior limit is frequently marked by a slightly impressed line; the sixth lies behind the others though at no great distance; the genera differ somewhat in the varied relations and exact position and size of the ocelli.

The head varies greatly in general contour, especially about the summit, which is occasionally produced into long, pointed horns, or bears elongated thorny tubercles or stout prickly spines. It is also generally covered to a

greater or less extent by papillae or tubercles bearing short or long hairs, or else hairs are found arising directly from the surface; for hairs in some form, either sessile or seated on papillae, are always found upon some part of the head; even of the *Lycaenidae*, where this region is retractile within the first thoracic segment (78-80).

I have here described the head as it appears, not in its morphological relations. There can be no question that ideally the head is composed of several segments, most of which bear a single pair of inferior organs homologous to legs, such as the jaws, maxillae, etc. So, too, I have spoken of an outer and an inner maxillary palpus, and in treating of the imago shall refer to a single pair as *the* maxillae; but much confusion has arisen among entomologists in the application of these terms; ideally, and sometimes actually, the maxillae of insects bear three palpi, any one of which may become specially developed and receive the name of maxilla, while the others are termed palpi; thus the organ called maxilla in one group is not always strictly homologous to what bears that name in another group. These, however, are not subjects for discussion here, and are only mentioned to prevent misapprehension.

The body and its appendages. The body is composed, as has been stated, of thirteen segments (Compare Packard, *Am. nat.*, xix: 308). The integument is only occasionally, and in special areas, of a corneous nature, being usually more or less leathery; the intimate structure is exceedingly variable, as shown by Minot (*Arch. mikr. anat.* 1886), and would doubtless furnish excellent points of distinction and affinity if carefully studied. The rings of the body resemble each other essentially, although they may bear very different organs or vary considerably in size; the first and the last, however, often differ from the others in their general appearance more than the rest do among themselves. The first is attached to the head by a continuation of its more or less coriaceous integument, and varies more than any of the others in size; sometimes, as in *Lycaeninae*, it is very tumid and permits the head to be entirely withdrawn within its folds; or the segment partially covers the head, as in the *Papilioninae*, and bears a pair of extensible scent organs; at other times it is extremely small, forming as in the *Hesperidae*, a sort of neck between the head and the rest of the body; and then the upper surface is usually covered in part by a horny shield. The armature borne by the first segment generally differs from that upon the other segments, being more diminutive in size or less conspicuous in nature. Sometimes, however, as in some *Argynnidi*, a part of it is more conspicuous. The terminal segment differs from the others more by reason of its position than from any other cause; frequently it is simply rounded behind; at other times it develops, as in *Chlorippe* and the *Satyrinae*, a pair of backward projecting tapering prolongations; very often it has a slight central tuberculated extension. Usually the hairs are longer

upon this segment than upon any other; and like the first segment it seldom if ever bears appendages of quite the same character as the rest of the body. With these exceptions, however (and the presence or absence of legs and spiracles) the joints of the body are very similar to each other. They may be divided into thoracic and abdominal according as they belong to these prospective regions, the former bearing each a pair of legs, the latter bearing prolegs only, and always on the third to the sixth and on the tenth abdominal segments.

The legs (87:13) are five-jointed, the basal two joints usually large and fleshy, the apical three generally coriaceous or horny, longer than broad, the last armed with a simple, small, bent or curved, often heeled claw. The prolegs (86:27,31; 87:21) consist of two very large, fleshy, short and stout joints, the apical bearing on the inner side of its tip a pair of thickened pads moving laterally, the outer and sometimes the inner of which bears a strongly curving row of minute hooks; the ventral prolegs are directed downward, the anal pair or that of the tenth segment both downward and backward; the latter are also a little larger, and the pad provided more abundantly with hooklets. The long basal portion of the hooklets is lightly imbedded in the skin and the exerted portion is slender, strongly curved and hooked, the hook sometimes blunt and sometimes pointed; they are sometimes arranged in single, sometimes in double or triple rows, and apparently can be extended somewhat at will; the tip of the foot between the pads may be so inflated, especially in the Papilioninae and Hesperidae, as to bring the rows of hooks outside and thus the pads can be opened or shut at pleasure, the animal cling with great tenacity to any object upon which it is standing, and also readily disengage itself. The hooks are always numerous, thickly crowded, and increase in number with age; sometimes as many as one hundred are found on each foot.

Breathing pores or spiracles, sometimes called stigmata, occur only on the first thoracic and first to the eighth abdominal segments*; they are situated a little below the middle of the sides, in the centre or slightly in advance of the centre of the segments, and consist of straight slits transverse to the body, surrounded by a thickened lip, the outer margin of which is usually oval and frequently raised; the spiracles of the first thoracic and eighth abdominal segments are frequently higher than the rest, especially in the Lycacninae and Hesperidae, and also often larger.

* In some Lepidoptera, as in the young caterpillar of *Pamphila mandan*, spiracles may be found on the second and third thoracic segments; and in many others there are false spiracles, having no connection with the air tubes of the interior, which ramify in these segments, as will be seen, quite as in others. My attention was first directed to the occasional presence of true spiracles on the hinder thoracic segments of lepidopterous larvae by Dr.

Algernon Coolidge of England, through Rev. Mr. Hellins of Exeter. On drawing Dr. Packard's notice to the subject he discovered the clustered tracheal tubes though without external sign of spiracles in the larvae of one of the Sphingidae and in *Platysamia cecropia* (Am. nat., viii: 531). I believe these last may be found in all Lepidoptera. In the perfect insect, as we shall see, there is a mesothoracic spiracle.

The thoracic and abdominal segments also differ frequently in the position of the armature borne by the segments, and whether these consist of simple or compound spines, tubercles, bristle-bearing papillae, or fleshy filaments, they are usually arranged in several definite longitudinal series; but such series are frequently broken at the division between the thoracic and abdominal segments, a subdorsal abdominal series, for instance, becoming laterodorsal on the thoracic segments; sometimes also a series is limited to one or the other region. On this account and in order to give greater precision to descriptions of the parts of caterpillars, I have here adopted a uniform nomenclature to designate the precise height on the body at which the serial appendages occur, as follows: *dorsal* or *mediodorsal* for a line passing down the middle of the back; *stigmatal* for a line passing along the spiracles; *lateral* for a line midway between these two; *laterodorsal* for a line midway between the mediodorsal and the lateral; *subdorsal* for a line between the mediodorsal and laterodorsal; *supralateral* and *infralateral* for lines just above and below the lateral; *laterostigmatal* for a line midway between the lateral and stigmatal; *suprastigmatal* and *infrastigmatal* for lines just above and below the stigmatal; *ventral* or *medioventral* for a line passing along the middle of the belly; *subventral* for a line close to it; *lateroventral* for one still further removed from the medioventral; and *ventrostigmatal* for any between this and the infrastigmatal line. The necessity for precision is greatest above the spiracles, for the armature of the caterpillar is found, as would be expected, almost entirely upon the upper surface of the body. All of our butterfly caterpillars are clothed with hairs, although in the Papilioninae and Euploeinae they are so short and delicate as to leave the creature a naked appearance, and in addition to this most of them have other tegumentary appendages in different parts of the body; their arrangement affords admirable generic characteristics which have not hitherto been sufficiently appropriated.

In this connection it should be stated that in the character of the armature both of the head and body enormous differences will be found between the young and mature larvae of the same species,—differences which until recently appear to have been entirely overlooked. In fact juvenile caterpillars in their first stage may be tersely said to differ generically from themselves at a mature epoch. In some the change becomes an abrupt one at the first moult; in others it is brought about by comparatively slight alterations at successive moults. The differences consist, for example, in the presence in some juvenile larvae of papillae, emitting hairs, sometimes of excessive length, arranged in definite series, all of which entirely disappear at maturity, the body being then clothed only with short uniformly distributed hairs seated on papillae; or, to take another instance, the head of a newly born caterpillar, covered with several large tubercles which entirely destroy the regularity of its contour, gives place to a well-

rounded head whose summit bears a pair of excessively produced conical appendages; or again, hairs seated on papillae arranged in definite series in a juvenile caterpillar may be supplanted by thorny spines, arranged also in definite rows in the mature larva, but occupying an entirely different position from the series seen in the young. An examination of the descriptions in the body of this work will afford many other instances quite as striking as those given; and from the observations of others on many different groups of insects I am inclined to believe that this is but a too partial statement of a general law. (Compare plates **70-73** with **74-77**; see also plate **86**.)

Besides the clothing or armature of the body proper, there is another feature which may draw our attention for a moment. Each segment is divided into sections or sub-segments, as perhaps they may be called, by transverse creases which extend around the entire body excepting the ventral surface; it is as if the division lines between adjoining segments were not sufficient for the free motion of the creature. These creases, which have greater or less distinctness and depth, are found in allied insects at the same place, so that even some groups of considerable size may be characterized by the number of the sections into which the principal body segments are divided. As a general rule these are nearly the same on successive segments of the body, but the thoracic segments often differ from the abdominal to a greater or less extent, and the first and last segments of the body rarely agree with the others. In the following, note is made only of the distinction seen in the abdominal segments.

In a few caterpillars these segments do not seem to be divided at all. Such are our native *Papilioninae* with which also the gerontogæie *Thais* agrees, although some of the allied genera, *Parnassius*, *Doritis* and *Ismene*, have three or four sub-divisions. The same simplicity is found in the *Chrysophanidi*; and indeed the same is the case to a nearly complete extent in all the *Lycaeninae* though, excepting in the *Chrysophanidi*, they are often faintly separable into two subsegments. The only genus of *Lemoniinae* which I have been able to examine, the European *Nemeobius*, also has two subsegments, though the hinder of the two is again subdivided equally. So, too, all the *Argynnidi* and *Melitæidi* have two subsegments, the anterior, as is nearly the universal case, considerably larger, excepting that in our species of *Brenthis* the hinder subsegment is again divided. The *Heliconinae* agree with the *Argynnidi*, while in the *Euploeinae* not only is the hinder half subdivided into two subsegments, but the anterior half as well, though somewhat obscurely. The next degree of complication is found in the remaining *Nymphalinae* which have four subsegments, the anterior the larger and always bearing the principal armature, the hinder portion being subdivided into three smaller subsegments. *Anaea*, however, has the hinder portion subdivided into four subsegments. It is curious to note in

this connection that *Libythea* has four subsegments as in the bulk of the *Nymphalinae*, although in this case the four subsegments are of nearly equal size. In the remaining *Nymphalidae*, that is, in the *Satyrinae*, we find a decided difference, the front subsegment only a little larger than the rest or scarcely larger at all, and the whole segment divided into six subsegments. A single exception only has been noted in the fifteen species that I have been able to examine, and that is in the European *Hipparchia hyperanthus*, which has only four subsegments, the front one no larger than the others, while *janira*, placed next it by some European entomologists, has the normal number. Closely agreeing with them are the *Pierinae* which usually have six subsegments, but in the European *Aporia* the last two are hardly separable. A curious exception however is to be found in the *Anthocharidi*, which usually have seven subsegments, including our own *genutia*, though the European *belia* has but six subsegments, and the species of *Zegris* only five and the last two of these scarcely separable from each other. In the lowest family we find a distinction between the *Hesperidi* and the *Pamphilidi* in the greater number of subsegments belonging to the latter group. The *Hesperidi* usually have five, the first of them the larger. But our *Hesperia montivagus* has only four and the same is the case with two species of *Thanaos*, *persius* and *lucilius*, while *Thanaos juvenalis* and another unknown species agree completely with the bulk of the *Hesperidi*. The *Pamphilidi* on the other hand have seven subsegments, though a remarkable exception appears to occur in the European *Adopaca lincola*, in which the subsegments behind the first appear to be paired, so that there are here but three where ordinarily there are six.

Finally a few words may be said regarding the glands having their external opening upon the surface of the body. These may be divided, perhaps naturally, into two groups, according as they occur upon the thoracic and abdominal segments. Thoracic glands are apparently found in the caterpillars of all butterflies though they are best known, as they are the most striking, in the caterpillars of the *Papilioninae*. Here they are found on the dorsal surface, bear the name of *osmateria*, and consist of a fork-shaped sac which, ordinarily drawn entirely within the body, may be almost instantaneously thrust out through a transverse slit in the first thoracic segment. This organ when thus extruded is generally of a bright color and exhales a more or less decided odor differing according to the species, being scarcely perceptible in *Laertias* and varying through all degrees of offensiveness to a truly sickening stench in *Iphiclides*. The construction of this organ has been described in somewhat different terms by Studer and Klemensiewicz. It is really a development of the integument and the cells at its base are glandular, their secretion being perhaps discharged through pores of the adjoining cuticula. "It may be assumed," says Dimmock, "that the odorous secretion accumulates in the invaginated

horns and is freed by their exertion." When withdrawn, this organ lies with one of its horns on either interior side of the body, extended backward to the first abdominal segment according to Klemensiewicz, but to the third according to Studer, who both studied the same species, *Papilio machaon*. Both agree that a delicate muscle is attached to the tip of each horn, which has its insertion, according to Studer on the dorsal, but according to Klemensiewicz on the ventral side of the body. It is by this muscle that the osmateria are withdrawn, and this explains why, during withdrawal, one may move quite independently of the other, and that the invagination begins at the tip. The extrusion of the osmateria is presumably brought about by the muscular contraction of the walls of the body, which forces the fluids of the body into the reversed osmateria. Inasmuch, however, as all the butterflies which do not possess osmateria are furnished, as far as I have examined, on the ventral surface of the first thoracic segment, directly in front of and between the first pair of legs, with a more or less prominent extensile bladder-like vesicle (86:36; 87:10), which when withdrawn presents a transverse slit very similar to that which is found upon the upper surface of the *Papilioninae*; and inasmuch as none of the *Papilioninae* possess this inferior vesicle, it may be presumed that this organ may have a similar object: but its precise use has never been clearly made out, though it has been known since the time of Bonnet a century and a half ago.

The abdominal glands are of two types, and, as far as is known at present, are found only in the single subfamily *Lycaeninae*. One of these types (87:19) is very similar to the inferior glands of the first thoracic segment, but is found a little behind the middle of the dorsal surface of the seventh abdominal segment and is indicated by a transverse slit at this point, through which there may be occasionally protruded a minute globular vesicle, which seems to secrete a fluid of some sort, inasmuch as it is a point of great attraction to ants. This vesicle probably exists in all the *Lycaenidi* as well as in some *Theclidi*, and though it has not been found in any of our *Chrysophanidi* it does occur in the European *Thestor ballus*.

In addition to this form of gland there are found in some species lateral extensile organs or caruncles, which may be seen upon the sides of the eighth abdominal segment (86:14; 87:14,19). These consist of extensile organs which when fully exerted are cylindrical, with a rounded summit besprinkled with spiculiferous needles; excepting in *Thestor ballus* I have been unable to find them in any group besides the *Lycaenidi* and here they are by no means invariably present. These curious appendages were first observed by Petzhold and the attraction to ants of the central gland found upon the segment in front was first noted by Esper. Whether any odor accompanies the extrusion of these lateral organs of the eighth abdominal segment is uncertain. In the Indian *Curetis thetys* (figured by Horsfield, Cat. Lep. E. I. Co. i, pl. 12, fig. 5 — not 7 as stated in expl. pl.),

as explained to me explicitly by Mr. de Nicéville, they form immense non-retractile pillars, doubling the height of the body at this point; or rather the body is thus elevated and from the summit of the pillars "issue when alarmed two long filaments or tentacles fringed with very long hairs . . . which it whirls around with altogether astonishing rapidity, doubtless to frighten away ichneumon flies." The caterpillar Mr. de Nicéville tells me is not attended by ants, and therefore probably lacks the slit in the preceding segment.* In our species the caruncles are so minute as scarcely to be visible without a lens, but as pointed out by Dimmock their accompaniment by hairs exposes still more surface to the air, and this gives a better chance for spreading any odors which they may secrete. Both this organ and the osmateria are so constructed as to present, says Dimmock, "the greatest economy in the use of an odorous fluid . . . by exposing suddenly a large surface moistened with the fluid to the surrounding air."

It is in every degree probable that other abdominal glands will be found in caterpillars just from the egg, for the flaring-tipped hairs serially arranged with which so many juvenile and some adult caterpillars are clothed (*e. g.* *Pieris*) may frequently be seen under the microscope to exude at the tip a droplet of fluid, the source of which can only be presumed, as in similar appendages in lower *Lepidoptera*, to lie in a gland at the base of the hair, which is always mounted upon a conical papilla. But this is a subject upon which no writer has yet ventured either experimentation or discussion. Other structures in the caterpillars of various *Lycaeninae* at birth may possibly have some similar purpose.

Internal organization (Plate 62).

In considering the external crust of the caterpillar and its appendages, we have been able by its very organization to examine each part separately without confusion; for, by the division of the body into distinct regions, and of the regions into separate rings, each bearing its special appendages, the mind can readily locate these and recall them when necessary. The same will also be found to be true of the future stages of the animal's existence. When, however, we come to the internal parts, the case is generally different; for both now and later the organs run in a longitudinal course through the body and disregard in great measure not only the jointed structure but even the regional distinctions of the body. To systematize our examination, therefore, we must treat them differently, and, separating them into natural subdivisions according to their functions, discuss them in that sequence which promises to give us the clearest conception of their use.

As the basis of the whole, we have the structural framework of the animal, its outer crust; and since power of movement is the primal need

*The first segment on the right in Horsfield's figure is the first thoracic, the head being retracted beneath it, and so altogether out of sight.

of a living creature, we shall first consider the muscular system, through which the framework and its appendages are moved; next we shall take up the digestive system, the province of which is to prepare crude nutriment for the insect; the further preparation of this nutriment by oxygenation requires that we should follow with the respiratory system; and the distribution of the nutriment over the body by the circulatory system completes the circuit of the relation of food to the creature; but whether the natural action of these systems be voluntary, as in the first mentioned, partly voluntary and partly involuntary, as in the second, or wholly involuntary, as in the last two, they all require to be brought into relation to the will of the animal, or their vital action ceases; we shall therefore consider next the nervous system, the seat of volition and sensation. We shall follow this with the glandular or secretory system, since its sole independent representative is the organ which serves to secrete silk, by means of which the caterpillar is able to walk where it needs to procure nourishment. These are all the systems which have to do simply with the life of the individual, but there is still another, the reproductive, which must take the highest place as related to the life of the species; though in the caterpillar this remains in an embryonic condition, a condition of preparation for future development; and finally we shall consider briefly the cellular system, whose extreme development is confined to the larval stage and is intimately related to all the other systems.

Muscular system. The muscular system of caterpillars consists almost entirely of flat ribbons of simple muscular fibre. For convenience sake, and also to a limited extent as a natural classification, they may be divided into those occurring in the head and those confined to the body.

The head is mostly filled with conical muscular bundles, attached by their bases to the upper and lateral portions of the posterior two-thirds, and to some extent to the upper portion of the anterior third of the vault of the head; the apices of these conical masses converge toward the middle longitudinal line of each hemisphere, and then pass downward, terminating, in the lower half of the head, in a white, glistening, tendinous cord, lying just behind the optic nerve and reaching down into the mandibles, which they serve to close. The extensors of the mandibles are attached behind and below the ocelli, and pass directly to the outer base of the mandibles, which they enter by means of a tendon attached to the interior wall of the same. The retractors of the labrum are slight, flat, muscular ribbons, attached at one extremity along the whole of its upper interior edge and at the other to the facial triangle; the labrum is drawn inwards by a double muscle, which starts above from its attachment along each side of the median suture above the facial triangle, and passes freely downwards, the muscles of the two sides confluent, diminishing in breadth downward, and terminating in a single tendon attached to the middle of the labrum.

A band or ribbon, made up of simple, longitudinal, parallel, muscular fibres, collected into two contiguous strips, the inner the narrower, runs from one end of the body to the other, near the skin, between the spiracles and the ventral side of the body. In *Euphocades*, however, the double strips form on each side one broad ribbon made up of from fifteen to twenty-five independent, similar, contiguous cords. Each strip is properly made up of a series of bands, one to each segment, extending across its entire length, and they are permeated by minute tracheal vessels running mainly at right angles to the direction of the fibres. From the anterior end of the inner strip of each segment, a slender muscular strap runs obliquely to the middle of the ventral line of the segment. Beneath the insertion of the longitudinal bands sets of nearly parallel but slightly converging bands run to the ventral line at the middle of the front of the succeeding, or at the posterior edge of the same, segment. Above the spiracles, on each side, are three slightly oblique muscular ribbons, the lowermost lying nearer the integument than the others, its lower edge touching the base of the tracheae. These three strips are not continuous on succeeding segments, but the innermost broadens posteriorly and becomes two in the succeeding segment, its inner half repeating the same on the next segment and so on. Beneath all these longitudinal bands, as seen from within, *i. e.*, lying nearer the integument, and at the anterior edge of each segment, a narrow transverse belt encircles the whole body, passing at the stigmatal line over the longitudinal tracheal vessel which unites two contiguous spiracles, and strapping it to the integument.

The flexor muscles of the true legs originate in the body just beneath the origin of the outer of the two longitudinal muscular ribbons of the ventral surface of the body, and extend to the opposite wall of the segment. The muscles of the prolegs consist of flat bands forming a muscular coating to the walls of the legs, passing in a direct line downward, narrowing as they go; they do not cross each other, nor pass to opposite sides of the legs, but are entirely simple.

Passing now to the muscles attached to the internal organs, we find the coating of the stomach, which is a mere film, overlaid by delicate parallel strips of muscular fibres crossing diagonally in opposite directions; besides these there are longitudinal muscles arranged in sets, each set separated from its neighbors and composed of several slender bands, traversing the entire length of the stomach; those next the dorsal and ventral lines are more prominent than the others and on the anterior are larger than on the posterior half; sometimes, however, the transverse encircling muscles are more highly developed than the longitudinal; the sets on the dorsal lines are united into a double band at the anterior extremity and pass to the oesophagus, where they are more widely separated; the oesophagus is provided also with other longitudinal muscles, and to a less extent with trans-

verse encircling bands. The small intestine is covered with both transverse and longitudinal bands of thick, white and glistening muscular tissue; at its anterior end especially, where the alimentary canal is greatly constricted, it is thickly covered with short longitudinal muscles, whose hinder extremities dovetail into other longer sets; besides these, there arise from the middle of the posterior end of the intestine a number of parallel bands of muscular fibre, which embrace it diagonally, passing around to the ventral surface of its anterior extremity; starting just in front of the posterior insertion of these, and interlacing with them at right angles, is another shorter set of parallel muscles, whose other extremities are attached to the body-wall; still further, a set of four independent parallel muscular bands passes beneath and supports the posterior end of the small intestine, reaching horizontally from the middle of one side of the eighth abdominal segment to the opposite. The colon is furnished simply with longitudinal and transverse muscular bands, heavier than those on the stomach-wall.

Digestive system. The digestive tract of the caterpillars of butterflies consists of an alimentary canal with anterior appendages (salivary glands) and posterior appendages (biliary vessels). The alimentary canal is a simple, straight, cylindrical tube, varied by expansions and contractions, which divide it into an oesophagus (at the anterior extremity of which the salivary glands are emptied), a long intestine, or stomach, if it may be so termed, a short intestine (toward the anterior end of which the biliary vessels are attached) and a colon.

The oesophagus consists of two parts: anteriorly a simple, straight, equal tube, and posteriorly a larger portion swollen in the middle—a sort of “crop”—which is better provided with muscular bands and extends part way into the cavity of the second thoracic segment. The stomach is much the more conspicuous portion of the alimentary canal and, indeed, the most conspicuous organ in the body; it is a straight swollen tube, always crowded with food, and only occasionally larger in the anterior portion because the animal has recently gorged itself; it extends from the middle of the second thoracic to the middle of the seventh abdominal segment and varies in size according to the amount of food that has been swallowed; the walls seem to be the merest film, traversed by muscular fibres, which by lines not deeply impressed divide the surface into narrow, rounded, transverse, parallel lobes, reaching from the middle of the upper or the under surface to the middle of either side and which alone prevent a perfectly free and direct movement of the fragments within. There is also an investing tunic of longitudinal muscles, and the two layers can readily be separated from each other. This organ seems to act mainly as the receptacle of the recently devoured food, since the fragments at the posterior end seem scarcely more digested than those which have just entered the anterior extremity. At the middle of the seventh abdominal segment, or

in the *Lycaenidae* much earlier, the alimentary canal tapers suddenly, being enwrapped by a strong band of investing muscles, and then enlarges slightly, and the intestine begins; this also consists of a straight cylindrical tube surrounded by thick walls of muscular tissue, both longitudinal and encircling, the former especially distinct and moulding the interior walls into very prominent longitudinal ridges; of which there are seven or eight in *Hamadryas*; it is of equal size throughout, a little more than half the diameter of the stomach, and generally extends half way from the end of the stomach to the end of the body. The colon is a simple straight tube capable of considerable expansion, but of the same size as the intestine when not distended by excrement; usually much shorter than the intestine and nearly globular when distended, it is sometimes (as in *Callophrys*) nearly as long; the inner surface is smooth, permitting the ready passage of the excrement from the body.

The salivary glands are a pair of long flat ribbons, extending from their attachment at either side of the anterior end of the oesophagus, backward, beside the alimentary canal. In *Anosia* they are straight, tapering slightly and regularly to a bluntly rounded tip, and look like flattened braided cords, being compressed along the median line, while each side is deeply excised at regular frequent intervals, into bead-like prominences. In *Polygonia* they appear as scarcely tapering tortuous threads, and reach the middle of the third thoracic segment, where they appear to be closely connected with some of the tracheal tubes at the base of the laterodorsal spines. They are straight, cylindrical, and scarcely tapering in *Hamadryas*, but form large and broadly tortuous tubes in *Callophrys*, their extremities attached near the middle of the thoracic region to the dorsal vessel. In the lower families they are flattened and ribbon-like; in *Eurymus* bent abruptly outward beyond the middle, tapering regularly to a bluntly rounded tip; in *Epargyreus* uniform in diameter, crinkled, reaching the front of the stomach, where they are attached to tissue about the dorsal vessel by a slender suspensory thread.

The malpighian or biliary vessels originate as slender organs, one on each side of the middle of the anterior half of the intestine; as tolerably large sacs in *Polygonia*, *Hamadryas*, *Callophrys* and *Eurymus*, in slender (*Anosia*) or very slender thread-like tubes, which either so continue (*Epargyreus*) or expand into a sac (*Euphœades*); at a short distance from the origin the vessel subdivides into three branches (the under branch originating just before, in *Epargyreus* a short distance before, the other two), which are strongly waved or crenulated cords, and are, throughout, nearly or quite as large as the tube or sac at its very origin; the under branch passes forward usually in a tortuous but in *Eurymus* in a straight course above the nervous cord, along and in contact with the under outer surface of the stomach, to a distance varying according to the group, from

about the front of the abdominal region in *Anosia* and *Callophrys*, to near the middle of the third abdominal segment in *Epargyreus*; here it bends upon itself and returns in a similar manner, a little higher up, to the point from which it started; the two other branches, which are a little smaller than the first, extend forward and then backward in a similar manner and to a somewhat similar distance, sometimes one of the three threads reaching farthest forward, sometimes one of the others, according to the tribe; one of the upper branches passes along the upper outer portion of the stomach, the other along its side; all three branches pass outside the tracheal tubes which invest the stomach, and when all have returned to the point from which they started, the extremities of the three are collected with those of the opposite side in a single intricate convoluted mass enveloping the intestine, and covering also the whole surface of the colon with their more delicate terminal threads. When the posterior part of the alimentary canal is pressed, whitish particles can be seen to move in an irregular manner within the malpighian vessels. In the characteristics of their main portion, the malpighian vessels are much slighter and shorter in *Euphoeades* and *Epargyreus* than in the higher butterflies.

Respiratory system.—The respiratory organs of caterpillars consist of tracheal vessels,—cylindrical tubes composed of closely compacted, shining, silvery, spiral threads, enveloped, or at least the principal stems, by the thinnest possible investment and ramifying endlessly; they have their origin at the spiracles, situated on either side of the body on the lower portion of the sides of the first thoracic and first eight abdominal segments—in the last segment a little higher up the sides than in the others, and especially so in the *Lycaenidae*. The tracheal trunks divide at their very origin into a considerable number of equal or nearly equal branches, which at once push their way into different portions of the neighboring organs, presenting an appearance resembling the aerial roots of some tropical tree; most of them reach the stomach and, diminishing abruptly in size, at once branch at wide angles and ramify all over it, every fold or lobule being tracked by two or three of the finest of the threads; the intestine is traversed only by the finer tracheal tubes; other shorter branches permeate the floating organs, attach themselves to the muscles and the nerves and track along the cord-like appendages. Each set of tracheae is connected at its base with the set in front of and behind it by a tube as large as any of them, which emits several short branches; thus if any spiracle is closed by accident its neighbors may do service for it.

These vessels are somewhat modified in the anterior portion of the body; the tracheae of the first abdominal segment are larger and branch more extensively than those of any other segment (although the spiracle is no larger than the others) their ramifications extending to the anterior extremity of the stomach; while those of the third and second and especially

the second thoracic segment, where there are no spiracles, are small and comparatively inconspicuous, and connected with the bunch in the first abdominal segment behind by only a small longitudinal canal. The first thoracic segment, which has a spiracle and generally one of larger size than usual, bears, however, an extensive bunch of tracheae. The anterior branch of this bunch supplies the head; it arches upward on each side along the hinder edge of the head, until it meets that of the opposite side, when the two join so strongly that considerable force is required to part them; and the only mark of separation is a pale line on the dusky surface. As soon as they meet, they bend toward the head, then separate and run side by side beneath the muscular mass which occupies most of the head, over the double cephalic ganglion and curve over toward the labrum. Before uniting, these two opposite branches emit from their anterior surface similar branches, which also run beneath the muscular mass toward the anterior and lower part of the head; some curve upward and embrace the muscular mass from below; half way between the spiracle and the top of the head this first-mentioned arching branch emits from its posterior surface a slender offshoot, which, together with another branch, coming almost direct from the spiracle, pass toward the tracheae of the opposite side, and unite at the median line with a similar set from the opposite trachea.

Circulatory system. The circulatory system consists mainly of the "dorsal vessel,"—a straight tube, lying along the middle of the back, next the skin; it seems to be composed externally of an excessively fine whitish pellucid film. It is of varying shapes, simple and uniform in *Anosia*, ending in a well-rounded tip at the extremity of the body; as slender as the nervous cord as far as the middle of the third abdominal segment in *Hamadryas*; but beyond this point, where it is attached to the wall of the body, it suddenly expands to a much larger size, and retains the same as far as the seventh abdominal segment; here and in the next segment it expands into a fusiform reservoir and then tapers to the end of the body; in *Callophrys* it is comparatively large and equal as far as the third abdominal segment, though it expands slightly at the point of attachment of the salivary glands near the middle of the thoracic region. The dorsal vessel is very elastic and flexible, and when one side is pulled even pretty forcibly the other remains in place. It is seen to be slightly enlarged at the division lines of the segments marking the ends of the chambers, where, by the reflection of the tissues, a valve-like structure is formed, by which the fluids are forced from one chamber into the next, the movement being from behind forward.

Nervous system (86:1). The nervous system of butterfly larvae consists of a series of horizontal disks, connected by a straight slender double ribbon, emitting lateral threads, and which runs along the floor of the internal cavity from the head, where it extends upward, encircles the

alimentary canal and expands into a pair of lobes, to near the tip of the abdomen.

Viewed from above, the cephalic ganglia consist of a pair of nearly globular or subpyriform lobes, closely joined by their inner edges, or at least in juxtaposition; they are situated in the very middle of the head, just above the beginning of the alimentary canal, and on a level, above, with the top of the frontal triangle. From the lower anterior outer angle of each lobe, the optic nerve, large at base, but gradually tapering beyond, passes downward, forward, and outward, in a straight course toward the ocelli; as it reaches them it expands into a broad field comprising the ocelli,—black conical masses, their apices plunged in the nervous tissue forming the field. Just behind the origin of the optic nerve another independent nerve arises, extending to the upper portion of the tendinous cord which terminates the great muscular mass of the head and moves the mandibles. A little further removed from the optic nerve, and on the lower anterior edge of each lobe, a little within the middle, another slender nerve arises, which runs in a straight course to the base of the antennae.

From the lower outer edge of each cephalic lobe a nervous cord passes downward and a little backward, the two embracing the oesophagus, and then converges until they unite in the suboesophageal ganglion, a horizontal lenticular disk, situated at the base of the head just above its hinder edge; just beneath the oesophagus these embracing cords are united by a cross thread; this suboesophageal ganglion throws out lateral nerves, directed forward and outward, and is strapped in its place by transverse muscles, one just in front and another just behind it, which originate together on the floor of the body; and the hinder of which is strengthened on each side by a secondary muscle, which runs backward beside the cord for a short distance, divaricating slightly.

The ganglia of the body-segments, which are similar in general character to the suboesophageal ganglion, are situated in or near, generally a little in advance of, the middle of each segment, as far as the seventh abdominal segment, where there is a pair, in close proximity, one behind the other, and with these the nervous cord terminates. All the ganglionic disks are connected by a pair of ribbons, generally lying in such close proximity as to appear to be single and straight, but anteriorly they are separated somewhat widely.

In leaving the suboesophageal ganglion, the nervous ribbons run nearly parallel, or with only a slight outward curve, to the first body-ganglion. Starting again close together at the middle of the posterior border of the first ganglion they diverge in straight lines, but very gradually, until they are nearly twice as far apart as the width of the first ganglion (which is often twice as far removed from the second as from the suboesophageal ganglion), and then converge more rapidly and enter the second ganglion

at its outer anterior border. The distance from the second to the third ganglion is effected in a similar manner. The fourth ganglion is but little removed from the third, being in fact nearer to it than the latter is to the point of greatest divergence of the ribbons in advance of it; it is sometimes situated in the middle of its segment as in *Euphœades*, sometimes at its anterior edge as in *Anosia* and *Eurymus*; sometimes wholly within though at the posterior edge of the last thoracic segment, as in *Epargyreus*; between the third and fourth ganglia the ribbon is straight, slightly longer than broad, broader than at any point posteriorly, and its separation into two cords is not readily seen, though in *Euphœades* it can be determined here as throughout the whole length of the cord. Behind this the ganglia are nearly equidistant (up to those of the seventh abdominal segment) and connected by a straight double ribbon, scarcely broader than either one of the cords between the second and third ganglia, and which is seen to be double only by the slight divergence of the cords in advance of each ganglion as they enter it. The last ganglion is situated in the seventh abdominal segment, just posterior to the preceding, and these two, of which the eleventh is the larger, either appear almost to coalesce at their adjoining edges, or they do completely coalesce, as in *Euphœades* and *Epargyreus*. From the second abdominal segment backward, the nervous cord does not come in direct contact with the alimentary canal, but considerable fatty tissue is interposed between them; in advance of this, however, the reverse is the case, the fatty tissue appearing as if strapped in its place between the nervous cord and the integument by the branches of the former.

From each side of each abdominal ganglion two lateral nerves are emitted, the anterior at right angles, the posterior in a slightly posterior direction and soon forking, and at their bases the two are connected by a delicate fibril. Besides these a lateral thread springs from each side of the main commissures just in front of the ganglia, and is sometimes almost transferred, as in *Euphœades*, to the ganglion itself. In the thoracic segments there is a similar arrangement of nerves, but in the first ganglion only the anterior lateral nerve is present, and it is directed forward; the third ganglion on the other hand follows the rule of the abdominal ganglia, while in the second, the nerves are confluent at their origin, directed at right angles outward, and almost immediately diverge at right angles to each other, one forward, the other backward. In addition to the lateral nerves, the terminal ganglion is furnished with two pairs of longer and stouter posterior nerves, reaching into the hinder segments, the outer cords trending somewhat outward.

Glandular system. The glandular system consists of only a single pair of vessels having an independent outlet at the surface of the body; these are the vessels for the secretion of silk; their outlet is upon the labium; and from this point backward they consist, first, of a delicate thread or

duct running back along the sides of the alimentary canal, in a straight, slightly wavy or tortuous course, to a point varying from the middle of the thoracic to the beginning of the abdominal segments; and second, of a larger but still very slender sometimes flattened tube or vessel proper (though scarcely larger in *Hamadryas* and *Aglais*), which has at first an irregular course but runs beside the stomach to a point of attachment on the same, generally in the sixth abdominal segment, terminating in a slender thread. It has the greatest and most complicated development in the skippers which spin more silk than others. In *Epargyreus*, for instance, the vessel begins to expand as it enters the abdominal region, and continues of the same diameter, as far as the beginning of the fifth abdominal segment; then it turns abruptly back upon itself, above its former course, as far as the front of the second abdominal segment; again turns back with equal abruptness, above its previous course, and, diminished to nearly one-half its former diameter, extends nearly to the middle of the third abdominal segment; it then turns upward at right angles along the walls of the stomach to the middle of the sides of the same, or a little higher, and again resumes its general backward direction; on this it extends, with a slightly wavy course, as far as the end of the stomach, when it turns downward and inward again and soon terminates in a blunt tip, its extremity scarcely slenderer than its width when it is freed from the coils on the sides of the stomach. The coiled or reversed portion covers a distance of 5.75 mm. The initial duct is 9.5 mm. long, the stouter part of the vessel 12 mm. long, and the slender terminal portion 11.5 mm. long.

The length of the initial duct is rarely so long as here and in *Hamadryas* is only about one-seventh of the whole, while the length of the whole varies from a little over 12 mm. in *Eurymus*, to as much as 65 mm. in *Anosia*. In all other species examined the sudden change of direction found in *Epargyreus* on the third abdominal segment is wanting, the second abrupt reversal of direction being the last. In some, as in *Callophrys* and *Euphœades*, the stouter part of the vessel—always the part before any reversal of direction—lies wholly upon the ventral surface beside its mate, but in others the two lie removed from each other in the lower portion of the sides. There is considerable variation too in the point at which the first and second reversals occur; in some the first is at the second abdominal segment (*Hamadryas*, *Polygonia*, *Callophrys*), in others at the third (*Eurymus*, *Euphœades*), while in *Epargyreus* it is at the fifth; the second reversal is always at the first or second abdominal segment; and beyond this point the narrowing tube has always a more or less tortuous course. Throughout, the alimentary canal is closely hugged.

Reproductive system. The organs of generation, as far as they are developed in the mature male larva, consist of a pair of compound organs,

situated in the middle or posterior part of the dorsum of the fifth abdominal segment, and connected by a slender thread to minute bodies in the posterior portion of the under surface of the last segment. The compound organs or testes are placed next to the alimentary canal, those of the opposite sides in juxtaposition but with no direct communication. They are more or less elongated, ovate or reniform in shape, bright colored, and quadrilobed, containing each four similar chambers in a row from in front backward; the anterior extremity of each testis ends in a very short and slender thread. Just behind each testis a delicate pellucid thread arises, which passes posteriorly and a little downward until opposite the spiracle of the sixth abdominal segment; here it plunges downward toward it, and passing through the mass of tracheae to those of the seventh segment, sweeps around toward the medioventral line of the body, and, passing through an independent muscular bundle scarcely larger than itself, which stretches transversely across the body at this point, enters a minute whitish sac, situated just beneath the termination of the intestine.

The ovaries of the female are situated in the same place as are the testes in the male, and consist of a pair of long obovate sacs, bluntly rounded at each end, vertically disposed, approximated, but with the lower end curved outward; they are white, and each consists of a bundle of four similar tubes. The whole structure is completely homologous with the corresponding parts of the male, and as will be seen the future development of the parts in one set is paralleled by that in the other.

Cellular system. A caterpillar seems made to gormandize; the muscles are few and either serve to give action to the alimentary canal, to transport the animal to a feeding spot, or to remove the old integument to admit a larger growth and greater capacity for food; they will not enable it, by rapid movements, to escape an enemy; those of the head—and there is little but muscle therein—are almost exclusively attached to the jaws; other organs serve the same purpose; the general cavity of the body is mostly occupied by the alimentary canal and its appendages; spinning glands fill some of the space, and they are used only to give the insect a foothold when eating or travelling in search of food; air vessels supply the means of using the food for nourishment; the nervous system is very slight and most of its ramifications are addressed to the muscles. Yet a considerable portion of the material in the cavity shows that this gormandizing has an immediate object;—namely, the storing up of nourishment for future use during the great changes that are to occur during the subsequent quiescent state; for, completely enveloping the alimentary canal and its appendages and occupying all possible space between this and the muscles, the fatty bodies are really the most conspicuous portions of the interior organism of a caterpillar; it is upon this that the parasites feed and in consequence of the loss of it that the animal attacked by them finally perishes.

THE PUPA OR CHRYSALIS.

The fond embrace, the tender kiss
Which love to its expression brings,
Are but the husk the chrysalis
Wears on its wings.

ALICE CARY.—*Latent Life.*

External features.

Chrysalids of butterflies present an outward appearance essentially distinct from that of either the caterpillar or the imago. Quiescent in condition, organs of motion are useless, and are therefore enveloped in sheaths and folded compactly upon and glued to the body, which on its part is entirely corneous for its better protection, and shows little of the primary distinctions into head, thorax and abdomen. The head is seldom distinguishable from the thorax by anything more than a sutural impression, or is slightly prominent, and although upon the upper surface there is a more or less distinct regional contour clearly dividing the thorax from the abdomen, it is entirely concealed below by the appendages of both head and thorax, which are those of the imago in a partially developed condition and are extended in an almost common mass over the whole of the thorax and half of the abdomen. In its forming condition all these organs can be separated from the body, but once hardened they are immovably attached to it.

It will, however, be both convenient and proper to treat of these different regions separately, in order to obtain a better notion of the exact structure of the insects in this stage.

The head. The head is a more or less rounded compact mass of about equal height and length but broader than either, usually occupying the whole of the anterior extremity of the body, but in *Lycaenidae* crowded, by the great expansion of the prothorax, entirely upon the under surface. There are no distinguishable sutures dividing the head into regions or sections. The outer anterior portion, covering the eyes of the future imago, is always more or less full, frequently protuberant and conical or pyramidal, apparently for no other object than to protect the parts beneath, although these would not seem to be so important in the economy of the future insect as other cephalic organs which are not so carefully guarded; the position of the eyes, however, is such as to render them more liable to injury, and it is noteworthy that these prominences are more marked in the *Nymphalidae* which hang by the tail and swing in every breeze, and in the *Papilioninae* (87:6) which, although girt around the middle, have the anterior part of the body projecting to an unusual degree, and being fastened by a loose girth have some freedom of motion, than they are in the other groups. In the *Pierinae*, however, the same object is effected by a single anterior projection in the middle of the head, which in a girt chrysalis

would protect these parts of the head as effectually as the double cornution of the Papilioninae. It is evident from the condition of the parts in the Pierinae, as from the nearly or quite equal development of all the parts of the eyes in all butterflies, that these projections are not for the purpose of affording additional space for the material which is to form the parts beneath. At the lateral base of the parts covering the future compound eye is a strongly curved, moderately broad and equal, smooth band, which I have termed the ocellar ribbon (86:22,23;87:24) because it seems to be correlated with the curving row of ocelli of the larval head, the anterior curving limits of which are generally marked in the larval head by a distinct impression (86:24). At the upper posterior part of the head the antennae take their rise, at some little distance apart, and at once diverge from each other, passing in exactly opposite directions along the hinder part of the head, between the front border of the prothorax on one side and the upper termination of the ocellar ribbon on the other, cutting off a portion of the latter, crossing to the thorax just below it and then continuing in a nearly straight line posteriorly, between the wings and the legs, over a portion at least of the abdomen. The front of the bulk of the head is limited below by an angular suture, making a projecting angle, from which a piece (the epistoma?) is sometimes cut off (87:15). Just below it, variously developed in form and size, but usually small, slender, longitudinal and pentagonal, is a piece, probably the labrum, which separates on either side more or less triangular opposing projections, broad at base, their apices joining or nearly joining beneath the labrum; these represent the mandibles. Behind these (87:6) is a long double ribbon, broad at base but narrowing for a short distance, and then continuing nearly equal side by side in a straight line posteriorly, beyond the hinder limits of the thorax; they are the lateral halves of the maxillae, the future spiral tongue; beneath their expanded base, entirely concealed, with no separate sheath of their own, but lying extended posteriorly and parallel to one another in a straight line over the thorax are the labial palpi.

The thorax. The thorax is distinctly divided above into its three usual sections, the mesothorax being invariably largest and more or less tumid, often provided with a greatly elevated central prominence and occasionally with lateral ones of lesser size; the prothorax, however, attains considerable dimensions in the Lycaenidae, in which respect their chrysalids resemble the larva rather than the imago; in all the other groups both the prothorax and metathorax are comparatively insignificant, the metathorax resembling the first abdominal segment; beneath and on the sides the thorax is entirely hidden by its own appendages and those of the head; the wings, suboval in form and of course very much smaller than in the imago, are spread over nearly the whole under surface and sides of the thorax and the basal four segments of the abdomen, the hinder part almost entirely con-

cealed by the anterior, which are superimposed upon them but allow of their appearance to a greater or less degree along their whole superior and sometimes posterior edge; the inferior edges of the wings sometimes adjoin near the tip, but usually the tongue and often also the antennae are interposed; at the very base of the superior and to a lesser extent at that of the inferior wings, the wing is shouldered, humped or spined and to these parts I have given the names of basal wing tubercles in my descriptions. Sometimes the wings are not raised by the thickness of their thecae above the general contour of the body, but at others they are considerably raised and even ridged at their edges. The legs are actually all bent at the apex of the femora, the femora directed forward, the tibiae and tarsi backward in a straight line; all the femora are therefore concealed; the tibiae and tarsi of the first two pairs lie side by side tapering and converging slightly toward their tip, the middle pair outermost, the two together filling the space between the antennae and the tongue; the hind pair, however, is entirely concealed, lying beneath the front edge of the wings; the appendages then lie side by side from the ventral line outwards, in the following visible order: (87:6,15) tongue, fore legs, middle legs, antennae, and wings; the tongue generally reaches as far as the wings but sometimes (*Lycaeninae* and a few *Nymphalidae*) falls considerably short of it, and at other times (some *Hesperiidae*) extends far beyond them, the portion beyond being free; the antennae also usually extend just as far as the wings, but sometimes (*e.g.*, *Papilioninae*) fall short of them by about one-fourth; the wings usually reach nearly, sometimes quite, to the tip of the fourth abdominal segment, while the middle legs are never more than about two-thirds as long as the wings and the fore legs are shorter still, especially in the *Nymphalidae*. In the suture between the pro- and mesothorax, close to its outermost limits, is the aperture of the thoracic spiracle (87:11), which is a narrow slit, in some groups (*e.g.*, *Nymphalidae*) concealed by a fold of the anterior edge of the mesothorax, and sometimes has its presence marked by a minute oval blister of independent coloring upon the mesothorax (*Lycaeninae*); while in others it is a minute circular orifice bounded by an equal, rather broad, semicircle or semioval of velvety, very close, and short pile, also upon the mesothorax (*Hesperiidae*). Although in the larval stage this thoracic spiracle belongs to the prothorax its relations in the pupal stage are rather mesothoracic.

The abdomen. The abdomen is cylindrical, consisting of ten segments, the third or fourth slightly larger than the basal, beyond them tapering rather rapidly. The basal four segments, as already stated, are concealed on the ventral surface by the appendages of the head and thorax, but they as well as the fifth and sixth are evidently of uniform length throughout; the seventh, eighth and ninth, however, are increasingly contracted upon the under surface in most species, causing this surface of

the abdomen to be nearly straight in a longitudinal direction, while the upper surface is strongly curved; in the Hesperidae, however, this is not the case. The tenth segment is peculiarly modified to form the cremaster or anal button (87:1), a more or less tetraquetral, tapering, curving, bluntly docked prominence, its convexity upward, homologous with the anal plate of the caterpillar, its apex and sometimes its inferior surface furnished with a very large number of long and slender, cylindrical, corneous hooks, strongly crooked and usually thickened at the distal extremity, by means of which the chrysalis is securely fastened to the silk the larva has spun. In the Lycaeninae the extremity of the abdomen is so curved over as to bring the cremaster upon the under surface and it simply forms a slightly tumid mass, bearing the hooklets on its outer and posterior edges. At the inferior base of the cremaster, upon the ventral surface of the ninth abdominal segment, is the closed anal orifice, its sides broadly but slightly tumid and these again often bounded by curving ridges ending in an anterior tubercle, homologous, as Riley has shown, with the anal prolegs of the caterpillar, the whole part being often so greatly developed, especially in the Nymphalidae, as to crowd still further the ventral surfaces of the segments just anterior to it. The spiracles are transverse slits bounded by semilunar lips and occur on the second to the eighth abdominal segments, those on the second and third being partially concealed by the upper portion of the wings. Occasionally (e. g., *Basilarchia*) a single segment, or more frequently (e. g., *Pieris*, *Laertias*, etc.) two or three consecutive segments on the anterior part of the abdomen have median or lateral prominences; but the most ordinary armature consists of series of tubercles, warts or simple spines arranged in longitudinal rows, in each of which there is one appendage to each, or nearly every segment, except the last two; occasionally there is a lateral continuous or nearly continuous ridge of considerable prominence, and there is also frequently a slight median ridge; transverse ridges of any considerable prominence seldom occur and are then usually confined, at least the conspicuous ones, to a single segment, and especially to the fourth abdominal segment.

Internal structure (Pl. 62, fig. 5).

For the sake of readier comparison, we will follow here the same order pursued in our account of the internal organs of the caterpillar; but so little is known of the variations in the internal structure of chrysalids of butterflies, that our account must be very imperfect.

Muscular system. The thorax is almost entirely given up to muscular bundles, the principle portion of which, for the movement of the future wings, is divisible into two sets. One of these sets is restricted to the lower part of the sides of the thorax, and its fibres are directed from the base of the wings toward the middle of the lower surface, those of the oppo-

site sides inclining towards each other at a little more than a right angle. In the V-shaped space between them, and including all the upper domed part of the mesothorax, is the other set, running longitudinally in superimposed layers. In general the muscles of the abdomen seem to be situated much as in the larva, but are more compact and almost or altogether longitudinal, the oblique muscles disappearing. Those of the under surface of the abdomen consist, on each side of the body, of a ribbon, composed of two contiguous strips, the outer slightly the broader, running next the integument through the entire length of the abdomen, the inner edge at about its own width from the nervous cord.

Digestive system. The oesophagus is a mere thread-like vessel and runs straight to the stomach; as it enters the abdomen it is at once directed upward and suddenly expands into a small, bulbous, muscular crop, the anterior upper part of which opens into the food-reservoir or paunch, a subfusiform blind sac, broadly rounded at tip, in the nearly adult pupa reaching the extremity of the third or fourth abdominal segment, and lying over the stomach; in the early stages of the chrysalis it forms with the crop a simple minute sac. Directly following this crop, the digestive track widens greatly and forms the stomach, a cylindrical tube, tapering in front, suddenly contracted at its posterior end. It is very large in the young pupa, but gradually contracts, terminating at last near the end of the fifth abdominal segment and only a little beyond the full grown food-reservoir. On each side, at the base, the stomach bears within some rounded lobes, nearly as large as the crop, and besides these, arranged in a row down each side of the median line, it is profusely covered with small pea-like pockets. The intestine in a nearly mature chrysalis is a rather large, cylindrical tube, about three times as broad as the oesophagus, slightly tortuous, especially anteriorly; in the mature chrysalis, however, considerable change has been effected, for the intestine has rapidly grown to a much greater length at the expense of its diameter, which is now hardly twice that of the oesophagus; it is a little larger at the two extremities, but otherwise equal and much more tortuous; at first it is directed upward, forward, and slightly to one side for a short distance; then it doubles upon itself, crosses to the opposite side, and moves upward in a tortuous manner to the colon, which it enters a little behind and to the left of its anterior extremity. The colon is a small, oval or pyriform sac and gradually passes into the broad straight rectum, which seems only a continuation of it.

The salivary vessels are composed of slender threads of a uniform size throughout, without any size distinction of duct and gland; they first run straight beside the slender oesophagus, until near the middle of the mesothorax, when they take a double turn, and beyond this are at first straight and reach only as far as the stomach; but afterwards they become very much longer, and instead of being straight form exceedingly fine, crinkled

threads, which collect in a longitudinally disposed mass on each side of and touching the oesophagus, forming by their convolutions a fusiform mass which extends to the middle of the metathorax.

The malpighian vessels arise at the hinder extremity of the stomach, sometimes without the intervention of any basal sac, the three branches arising almost together at a very short distance from the base of their common stem and parting from it at right angles. One of the branches extends along the superior lateral walls of the stomach, as far as the middle of its anterior half (perhaps farther, later in life) and then returns; the other branch of the outer set passes along the inferior lateral walls of the stomach; they are all very delicate, and after their return are strongly convoluted, enwrapping the intestine but not the colon.

Respiratory system. The tracheae seem to be much as in the larva, only greatly reduced in size, very delicate and not at all opaque. The tubes in the posterior part of the body are small, but from the third abdominal segment forward they begin to enlarge; this is especially noticeable in the longitudinal canals, which are everywhere larger than the other vessels, and largest in the first abdominal segments, but again reduced in size in the thorax, where they are less than half their former diameter.

Circulatory system. The dorsal vessel is a slender, equal canal, lying next the integument of the future imago (86:17). Between the fourth and sixth abdominal segments (behind which it is very obscure) it is firmly attached above, and again in the middle of the thorax, but elsewhere is free; on all the abdominal segments, behind the first, it expands laterally at the posterior limits of the segment; on the first segment it broadens slightly, and in front of the expansion begins to diminish gradually and slightly in size, so that when it enters the thorax (from the abdomen) it becomes reduced to half its former size. As it enters the thorax from behind it plunges downward to just above the oesophagus in advance of the food-reservoir, then passes rapidly upward again to the upper wall of the body, which it follows to the middle of the mesothorax, diminished again to half its former size, so as to appear a mere thread; and then, casting free again, passes forward as in the larva, reaching the oesophagus again in the prothorax in the young chrysalis; but as it grows older this part bends more and more, until in the mature chrysalis it has completely doubled on its course, running directly downward and backward until the oesophagus is nearly reached and then turns forward parallel to the latter.

Nervous system. The principal changes which take place during pupation are the enlargement of the cephalic lobes, the shortening of the entire cord, and the concentration of the thoracic ganglia. Between the cephalic and thoracic ganglia the nervous cord in *Hamadryas*, where we have studied it most attentively, is moderately broad, flattened and double; the thoracic ganglion, which is a compound of the five ganglia succeeding

in the larva the suboesophageal ganglion (except such as are absorbed *in situ*), is situated in the front part of the mesothorax ; it is oval and evidently composed of two unequal, anterior and posterior, elements, for slightly in front of the middle it is pierced by a vertical passage of considerable size, and the portion in front of this has a slight, independent tumidity ; from near the middle it emits lateral nerves, double at their origin, which pass toward the wings, and just before the hinder end a rather prominent nerve, which runs backward half way to the abdomen, parallel to the main cord and nearly as large as it, evidently feeding the legs ; besides these there is another similar pair, also running backward but divaricating a little, which originates from the widest part of the posterior portion. Behind this ganglion the cord is very slender and a little before entering the abdomen emits a pair of slender but very distinct nerves, which are directed backward but divaricate considerably, passing to the inflated longitudinal tracheal canals ; there is no ganglionic enlargement at their origin, but it perhaps indicates the site of the former sixth body ganglion. Immediately on entering the abdomen the nervous cord *appears* to thicken and forms a pseudoganglion of an elongate, fusiform shape, terminating just before the first abdominal ganglion ; this appearance, however, is produced by the fact that throughout the abdomen the cord is overlaid by an investment, mainly pellucid, but not pellucid enough to allow the true cord to be seen, excepting from beneath ; this investment does not cover the ganglia to an equal extent, but only as a film ; so that the abdominal development of the nervous system is an exceedingly delicate cord, expanding at four different points into lenticular, disk-like ganglia of a small size, but many times exceeding the cord in diameter, the whole enwrapped in this semi-pellucid investment which makes it appear of nearly uniform diameter, excepting in front of the first true abdominal ganglion, where the investment becomes swollen and less pellucid, resembling a greatly elongated ganglion. The purpose of this investment, the "bauchgefäß" of the Germans, is not understood, but that it is an integral part of the nervous system has been proved by Leydig, who pointed out that it was an expansion of the floor of the neurileme uniting above. The abdominal ganglia are equidistant in the mature chrysalis of *Hamadryas*, but vary with age and species ; the first, which is scarcely broader than the cord, and noticeable mainly by its whitish color, is situated in *Hamadryas* near the end of the second segment ; the second at the beginning of the fourth ; the third at the beginning of the fifth, and the last in the middle of the sixth segment ; the last is larger than the others and emits four delicate posterior nerves ; each of the abdominal ganglia is also provided with lateral nerves, similar to, but more delicate than, those of the larva. Between all these ganglia, the cord does not at first pass in a straight line but in tolerably strong lateral sigmoid curves, as if the ganglia were being crowded together faster than the cord could contract.

In Newport's observations (Phil. trans., 1834) on the changes in the nervous cord of *Aglais urticae* (86:2-12), he shows a more considerable change between forty-eight and fifty-eight hours than perhaps between any others of the stages he has drawn and described, which are successively (after the pupal state is assumed) 1, 13, 18, 24, 36, 48, and 58 hours. According to his account the second and third (original) ganglia at this period "approach and coalesce, and the double ganglion thus formed is only separated from the larger thoracic mass, composed of the fourth and fifth ganglia, and part of the sixth, by very short but much enlarged cords." As the figures given by him do not in themselves show how this amalgamation of the second and third ganglia is affected, I examined the nervous cord of *Hamadryas*, 48, 51 and 55 hours after pupation, with the following results: The pupa of 48 hours age differs from that of *Aglais* only in the separation of the fourth ganglion from the united fifth and sixth; very short and broad ribbons connected them, but they were unmistakably separated by half the width of the fourth ganglion; while the third and fourth ganglia were separated by about the diameter of the latter ganglion. At 51 hours the condition was more as represented by Newport at 48 hours in *Aglais*, the fourth, fifth and sixth ganglia being completely amalgamated into a single long ovate mass, while the third, though clearly distinct from the mass behind it, was separated from it by only less than half its own diameter, very short, stout ribbons uniting the two; it was also of the same size as at 48 hours, and the second ganglion, instead of travelling toward the third, as Newport asserts, retained very nearly or quite its own place, but was reduced in size, being gradually absorbed in place by the cord.* This absorption was entirely effected at 55 hours, as was also the complete amalgamation of the third ganglion with the mass behind it. The second ganglion then is not amalgamated with the third, but disappears in place—a point quite in keeping with the lessening importance, but continued integrity, of the prothorax.

In the chrysalis of the European *Mancipium brassicae*, however, in which these changes, in the wintering pupa, take place far more slowly, Herold figures the nervous cord as if the second ganglion did not disappear in place but united with the third to form a common mass from which the lateral cords of both the ganglia are represented as derived.

Reproductive organs. The only noticeable difference between the male organs of the young pupa and of the caterpillar is in the complete union of the glands of the two sides into a spherical body, and in the tortuous path now taken by the threads that unite it to a sac lying beneath the extremity of the alimentary canal. Its further development is entirely in these two latter parts; the threads merely grow in diameter and somewhat

*Brandt asserts, from observations on this and other species, that reduction in the number of ganglia takes place only by amalgamation, never by absorption (Hor. soc. ent. Ross., xv.).

in length and become the efferent ducts; where they enter the sac there is at the first a slight bulbous enlargement, and it is just here that the most remarkable growth takes place: the bulbs increase so as to become noticeable: then a constriction takes place in their common union with the sac; the neck prolongs to what is finally a slender tube, the ductus ejaculatorius, as large as one of the efferent vessels and much longer than the whole body of the insect, leading into the intermittent organ of the male; while the bulbs grow in a similar way to form a pair of tubular glands or seminal vesicles, into which, shortly before their union to form the duct, the efferent vessels open: and these various slender organs,—vessels, glands and duct are at maturity enwrapped and intertwined in a most intricate, common and indistinguishable, but loose, convoluted mass which fills the last four segments of the abdomen.

The testis is clasped by fine tracheal vessels which suddenly expand from the larger tube of one of the main stems arising in the fifth abdominal segment. In the mature chrysalis it is crammed with spermatozoa, which in *Aglaia* are of two sorts, one larger though only about three-quarters of a millimeter long and pretty regularly tapering, the other shaped as clubbed filaments less than a quarter as long.

The changes in the female organs are exceedingly similar. With the shortening of the body, the first change is in the sinuosity of the thread which unites the ever separate ovaries to the pair of sacs beneath the anal orifice: concomitantly the base of the four terminal threads of the ovarian mass begin to separate from each other, and this portion of the ovarian tubes practically remains merely a set of ducts, the parts beyond forming the ovary proper, developing enormously and containing eggs, usually in varying stages of development in each of the four tapering tubes of which it is composed on each side of the body, and which are united again at the tip, and are then fastened to the wall of the fourth abdominal segment above. But the important new developments arise, as in the male, just at the hinder extremity of the oviducts, for in a similar way wholly new organs are rapidly developed. The single accessory gland and the copulatory pouch originate on opposite sides, in an entirely similar manner to the paired accessory gland. All are at first mere bulbous excrescences of the base of the thread mentioned. But some develop from this beginning in one way, some in another, until in the mature pupa all the appendages of the butterfly are fully developed.

Development of the wings. Inasmuch as most of the changes in the organs from the larval condition to their perfect development take place in the intermediate quiescent state, we may here say a word about the development of the wings, which first appear as external organs in the pupa, although they should more properly have been considered in the preceding section, since they arise and develop in the larval period. In the

mature larva they will readily be found on the inner sides of the second and third thoracic segments, appearing as oval pads, permeated by tracheal vessels, situated just above and scarcely in advance of the base of the tracheae in the respective segments, those of opposite sides directed toward each other above. Their connection with the longitudinal tracheal canal, from which arise the threads which penetrate them, is so intimate that they have been described as originating from them; but in reality the wing arises at the very outset of larval life by the infolding of the hypoderm in such a way as to resemble the half-inverted finger of a glove, the point of which at the proper time pushes its way outward, and when the chitinous outer coat is cast off appears as an external instead of an internal organ. The legs and antennae, quite new structures, originate and develop in a precisely similar way. In the larval condition all are infolded hypodermal pockets.

THE IMAGO OR BUTTERFLY.

But O! what terms expressive may relate
The change, the splendour of their new form'd state?
Their texture nor composed of filmy skin,
Of cumbrous flesh without, or bone within,
But something than corporeal more refined,
And agile as their blithe informing mind.
In every eye ten thousand brilliants blaze,
And living pearls the vast horizon gaze;
Gemm'd o'er their heads the mines of India gleam,
And heaven's own wardrobe has array'd their frame;
Each spangled back bright sprinkling specks adorn,
Each plume imbibes the rosy tintured morn;
Spread on each wing the florid seasons glow,
Shaded and verg'd with the celestial bow,
Where colours blend an ever varying dye,
And wanton in their gay exchanges vie.

HENRY BROOKE.—*Universal Beauty*.

External structure (Pl. 62: fig. 1).

The head and appendages (87:25). The head of the imago, like that of the caterpillar, is normally composed of a definite number of appendage-bearing rings, but as these are greatly obscured by the excessive development of some parts and the abortion of others, we will confine our description simply to the parts as they appear, without reference to their morphological relationships.

The head as a whole is, in general terms, transversely obovate, whether viewed from above or in front, and is almost always much higher than long and more or less flattened behind, next the prothorax. It is compact, the sides occupied by globular masses of which the greater, and always the whole of the front, portion forms the faceted eyes. It may be divided into three principal areas: the front, the occiput and the flanks. The front occupies the whole or most of the front of the head between the eyes with the anterior half of the summit, is usually tumid to a greater or less extent, and devoid of any great irregularities of surface. The occiput, which

occupies an exactly corresponding position behind, is also tumid but generally enjoys considerable variety of contour within its own boundaries, the upper portion being not infrequently ridged, and the sides producing little prominences. The flanks have a regular surface, occupy most of the rear of the head, are bounded interiorly by the occiput and anteriorly and exteriorly abut upon the eyes, forming a part of the globe which they occupy.

The other parts in the structure of the head which require consideration are the eyes, the antennae and the mouth appendages.

The position of the *eyes* has already been stated. Anteriorly they always have a similar boundary, but posteriorly they do not occupy nearly the whole, and sometimes scarcely more than half of the swollen mass of which they form a part; they vary too in the tumidity of the mass, in most species being quite prominent, while in others and especially in the *Lycaeninae* they do not rise above the general contour of the surface of the head; ordinarily and in the two lower families always they are naked; but in the *Lycaenidae* they frequently have a portion at least of the surface sparsely covered with short exceedingly delicate hairs; and in the *Nymphalidae* they are often supplied with a pretty dense mass of rather long hairs, always standing erect and separate, and originating at the angles of the facets. The purpose of this clothing is difficult to understand. The eyes (86:20,21) are composed externally of exceedingly minute hexagonal facets, varying, so far as I have examined them, from about fifteen hundred to four thousand in a square millimetre. No butterflies are provided with ocelli, with the single known exception of the genus *Lerema*, where some of the species have a single ocellus in the middle of the front in one or both sexes; while in some of the lower families of *Lepidoptera* the normally posterior pair of ocelli alone occurs and is situated behind the antennae.

The *antennae* take their rise in little pits, allowing them full freedom of motion between the eyes, in the line between the occiput and the front. In the *Lycaenidae* they infringe a little upon the eyes, but in all the other families they are quite free from them. They are usually not far from the length of the abdomen, and are composed of a large and variable number of joints; there is occasionally a difference of one or two joints between the sexes, in favor sometimes of one, sometimes of the other. They are composed of three parts: the base, the stalk and the club. The base consists of two joints (the basal always smooth and naked) which are different in character from the remainder, being very large and stout, and capable of a great deal of motion upon one another and within the socket, while the other joints have little motion upon one another. The stalk is of very nearly uniform size throughout, the joints usually very much shorter near the base than in the part beyond, where they are uniform;

it is either entirely naked or is clothed throughout or in part with scales; the portion most frequently left bare is a median stripe along the under surface; in no case, so far as I have seen, are the antennae clothed with hairs. The club is a peculiarity of butterflies among Lepidoptera, whence the term "Rhopalocera" often applied to them. It consists of a regular thickening of the apical joints and varies greatly in extent and appearance; in many cases, the joints increase in thickness to so slight a degree and so gradually that, although the thickness of the club may be double that of the stalk, it is difficult to determine where one ends and the other begins; usually, however, it is not difficult to mark the limits, and the more so as the joints lose in length what they gain in thickness, and so present a second mode of determination. The club, like the stalk, is usually cylindrical, but is not infrequently depressed, sometimes to a considerable degree, or is even compressed or triquetral. It varies greatly in length but may be said to be usually of about one-sixth the length of the whole antenna. It ordinarily increases in size nearly to the tip and then decreases again with much greater rapidity, the terminal joint occasionally bearing a produced point at the tip; in the Hesperidae a number of joints are employed to form a long and tapering tip, sometimes nearly as long as the rest of the club; but in most butterflies the tip is bluntly rounded. The club is usually straight, but occasionally droops or is curved upward, or, as in the Hesperidae where the tip is produced, the tapering apex is turned at a strong angle outward and backward. In the scaled antennae one or two apical joints are usually bare to a greater extent below than above, as is a broad field on the under surface, — an expansion of the median stripe of the stalk. Often one or two slender carinae are to be seen upon the under surface and some little dimple-like depressions (87:8) arranged in a longitudinal row. The contour of the surface is rarely interrupted at the jointings, but in the arcuate clubs one side presents a serrate appearance from the projection of the apices.

The appendages of the mouth are the labrum, mandibles, maxillae, and labial palpi.

The *labrum* is only a slight rounded projection of the centre of the lower border of the front, transversely corrugated, soldered to the front and thus immovable; it serves by its position to guard the upper portion of the peculiar maxillae.

The *mandibles*, too, though somewhat variously developed, are greatly aborted, immovably soldered to the head, inconspicuous in size, triangular in form, and serve only by their situation to support the sides of the maxillae, which their apices usually touch.

The *maxillae* are undoubtedly the most peculiar, as they are the most characteristic organ of the Lepidoptera. In butterflies they are always enormously developed, as very long and slender closed tubes, hollowed on

their inner margin to form by the junction of the two a canal, open at the tip and conducting at the base to the oral orifice, and which is kept closed by the interlocking of finger-like plates on the edges of the lateral troughs (87:9,23). In the Hesperidae and next to them the Papilioninae this tongue reaches its maximum length, being sometimes twice as long as the body, while in the Satyrinae and some Lycaenidae it is proportionally shortest, in some cases hardly twice as long as the head. It is furnished at the tip for a greater or less distance with papillae specially developed probably as sense organs, which are much more highly organized in the two higher than in the two lower families, and may by their armature serve to rupture the nectar glands of flowers (61:26-35,39-45,51-57).

The *labium* itself is very slightly developed, being simply the framework, situated below the oral aperture far removed from the surface, upon which the greatly developed labial palpi are supported; each side has a cylindrical raised edge, upon which the jointed palpus is seated; usually this wall is low, but in the groups (such as the Pierinae) bearing a disproportionately long basal joint, it is exceedingly produced and itself bears great resemblance to an additional joint. The *labial palpi*, on the contrary, are excessively developed and three-jointed, the second joint being almost invariably the longest and usually much longer than the other two together; in the Hesperidae it is often very stout. The basal joint is short, excepting in some Pierinae, where it occupies the larger part of the palpus; while the apical joint, usually the shortest as well as the smallest, and sometimes quite minute, is at other times enormously developed, as in the Libytheinae; in the Hesperidae it is rarely one-fourth as stout as the middle joint, and though always straight, often appears as a mere point projecting beyond the apical hairs of the middle joint. The palpus is heavily clothed with large scales and usually heavily fringed below and sometimes above with a mass of long hairs, ordinarily compacted into a vertical plane, but in the Hesperidae sometimes so arranged, in a thick regular mat of scale-like hairs of unequal length, as to give the palpus a tetrahedral or triquetral appearance. They thus guard the sides of the rolled-up spiral maxillae which they pass in their course; they are directed upward and sometimes apically forward, clasping the front of the head, the shortest (in the Papilioninae and some Lemoniinae) reaching only as far as the lower edge of the front; usually they are much longer than the eye and in Hypatus are fully four times its length. The apical joint is usually clothed and fringed to a less extent than the other joints.

The thorax and appendages. The thorax of butterflies, as seen from above, is composed almost entirely of the meso- and metathorax, the prothorax being represented only by a pair of bulbous enlargements which I have termed the prothoracic lobes (61:37), and which are almost always

reduced to a mere appressed pellicle in those groups which do not have the fore legs aborted in both sexes, as if in compensation for their atrophy. Cholodkovsky has recently tried to show that these lobes were homologues of the wings on the other thoracic segments, but entirely without success. The meso- and metathorax, which, although perfectly distinct, seem to compose one homogeneous whole, form a compact oval mass, the upper surface of which is arched and sides sometimes compressed. The mesothorax is far the most important and is composed of two unequal parts, a mesoscutum in front and a much smaller, somewhat wedge-shaped piece, the mesoscutellum, the apex of which enters the middle of the mesoscutum. The metathorax, on the other hand, as far as it is readily seen, is composed above of three pieces placed transversely, the central piece being the metascutellum, also more or less wedged between the others, the metascuta. Viewed from the side, the metathorax assumes a much greater importance. All these parts vary in comparative dimensions and relative positions in the different groups. It may be added, in general terms, that as regards the trunk of the imago, the families seem to be distinguished by the contour of the principal masses, while the subfamilies are dependent upon the shape of the grander parts which compose the masses, and generic characters are to be sought for in the structural details within the different parts.

The appendages of the thorax are two pairs of wings and one pair of patagia above, and three pairs of legs below.

The wings, never wanting in butterflies, are attached respectively to the meso- and metathorax; they are very large in comparison with the body and seldom more than twice as long as broad, although always longer than broad. The general form of the fore wings is a triangle whose truncated apex is at the point of attachment to the body; that of the hindwings subcircular, with a tendency also to the triangular outline. They are flat, excepting that sometimes the inner border and its outer angle in the hind wings may be guttered or plaited or bent at an angle. They are each composed of a thin double film of membrane, covered on both surfaces with imbricated scales and with scattered hairs, the latter particularly upon the upper surface and upon the hind wings near the base. This double membrane is stretched upon a regular system of tubular rods, termed nervures or veins, which hinge at the base upon the body; they conduct the nerves and air tubes to all parts of the wing. The normal number of veins in the wings of insects (38-42) is six, disposed to a certain extent in pairs; the middle pair usually branches to a greater extent than the others, and supports most of the membrane of the wing. In butterflies the foremost vein is always absent (except in the front wings of some male *Hesperidi*); the hindmost is also very commonly wanting, so that there are usually only five (often only four) principal veins, rather inappropriately designated costal, subcostal, median, submedian, and, when

present, precostal and internal.* The precostal, costal, submedian, and internal veins are invariably simple and terminate at the margin or even disappear before reaching it.† The subcostal and median veins, on the other hand, are as invariably branched, and with their offshoots support nearly the entire wing; the subcostal vein curves downward and the median upward so as to meet, or nearly meet, about the middle of the wing, and to inclose between them a large space called the discoidal cell; all the branches of the median vein are thrown off from its lower side before union with the subcostal vein; the principal branches of the subcostal vein, on the other hand, are thrown off from its upper side, but as the vein curves downward at the extremity of the cell, another set is thrown off, at least in the front wings, from the lower side; and it is these branches, rather than the subcostal vein proper, which unite with the median vein to close the cell. None of the median nor any of the inferior subcostal branches are ever forked; but at the apex of the front wing, where the play of neurulation is usually the greatest, the last superior subcostal branch is occasionally forked. The neurulation of the wings, then, consists essentially of upper and lower simple straight veins, and a pair of middle veins which unite with or approach each other near the centre of the wing; and from the outer edge of the cell or loop thus formed throw off to the border a number of branches. The veins are more closely crowded next the front edge of the front wings to give greater solidity to the parts which meet with the greatest air resistance in flying. No cross-veins proper exist in butterflies, excepting that one occasionally (especially in Papilioninae) connects the median and submedian veins next the base of the fore wings. All these nervures and their branches, when they do not run into one another, terminate at the border of the wing, and by their extension determine to a great extent its form; for though the membrane often recedes between the tips of the nervures so as to give a scalloped margin to the wing, this never takes place to an excessive extent; while the thrusting forward of the subcostal nervures of the front wing necessitates a more or less falci-form outline; or, the great extension of a single nervure of the hind wing, as particularly of the third median nervule in the Papilioninae, or the first median in the Lycaeninae, permits a tail-like appendage of great beauty.

In connection with the wings it will be well to mention the epidermal covering characteristic of the order to which the butterflies belong, since it is upon the wings more than upon any other part of the body that they take the form of scales from which the name Lepidoptera has been derived. The *scales* are depressed sacs of a more or less rounded, quadrate or triangular form, striate upon the upper surface, usually rounded, also deeply

* Spångberg calls them (in the most recent paper on the subject) costal, subcostal, radial, ulnar, anal and axillary.

† The internal, in the front wings, and especially in Hesperidae, sometimes terminates by running into the submedian.

and finely toothed at the apical margin, and at the base constricted into a pedicel with an extreme bulbous expansion by which they are held in place in pockets in the membrane of the wing. The pockets being regularly distributed, the scales are arranged in rows, very much as the slates upon the roof of a house, those of one row alternating with those of its neighbors and the base hidden from view and specially guarded. It is through the coloring of these scales that all the wonderful variety of the markings upon the wings of butterflies is produced. Many studies of the scales have been made, and their essential identity with hairs clearly established. Every gradation between the two may be found, and those in different parts of the wings often assume special forms.

In the male sex the variety in the form of scales is often far greater than in the female (46-51). For, certain scales of peculiar form, and in some cases at least serving as outlets to scent-glands, may be found either scattered irregularly over portions of the wings or clustered into definite areas. In many cases, especially where it is certain that they are the vehicle for the diffusion of odors from glands, they are attenuated and very delicately fringed, and each microscopic filament of the fringe is a tubular canal connecting with ducts in the membrane of the scale itself to the base where the glands are situated. As the various forms which these scales may assume will be specially treated in the body of this work, and their position in different groups directly specified, it will be unnecessary here to enter into further details, but a further word may be added regarding the structure of scales in general.

In general scales may be said to be nothing more than modified hairs. They originate in precisely the same manner and have the same histological structure. As already said, they may be called flattened scales, being made of two tunics with a hollow interior, forming in fact a closed bag. Originating in a somewhat bladder-like form, the contraction of the upper surface as they become flattened tends to render this surface striate, and the larger striations which are readily seen upon the surface of all scales is confined, as is shown in the cross section at Pl. 61 : fig. 38, to the upper surface only. Some scales contain no coloring matter, but they always include some amount of air. As Dimmock has pointed out, the ordinary scales of *Pieris rapae* and the metallic silvery scales of the spots on the under surface of the fritillaries contain no appreciable coloring matter and both contain air; and he believes that, as in a common mirror the mercury amalgam serves to give a silvery reflection, so the layer of air cavities in the interior of these scales answers the same purpose, the colors being only optical effects produced by reflected light. But in most scales, there is plainly a pigment enclosed between the two layers of which the scale is composed, sealed up as it were for better protection against the action of the air, and which, according to Burmeister, is principally attached to the upper layer of the

scales, rendering it opaque, while the lower layer receives less of this deposit and is consequently a little more transparent. Whence it follows that the colors of the scales as a whole are more vivid upon their upper than upon their under surface. The changeable and iridescent colors of some butterflies, on the other hand, which are seen far more rarely in butterflies of the temperate regions than in those of the tropics, are not due in any sense to a pigment but solely to the reflection of the light from the fine impressed striae upon the scales. As a general rule the scales peculiar to the male sex have little or no color, but there are some exceptions, as in the various species of *Argynnis* and its allies, where the basal portion of the scales is of a deep black color. While colorless scales, excepting such as occur in the vitreous spots upon the surface of the wing of some butterflies, are otherwise of comparatively rare occurrence.

The *patagia* are slender, small pieces of membrane, curving around the anterior base of the fore wings and connected with the trunk by a slender attachment just in front of the wings; the portion in front of the wings is very short, the main part being applied to the upper surface of the base of the wings, and often extending to a considerable distance posteriorly; they serve to protect the hinge of the wings from injury and are densely covered with scales or hairs or both; there are none in front of the hind wings.

The *legs* (52-60), as in all true insects, are six in number, one pair to each division of the thorax. They are invariably very slender and agree in their parts and generally in their proportions, although not minutely. As we ascend the structural scale, however, the front pair becomes more and more atrophied, first in one sex, afterwards in both, as will be hereafter detailed. The leg is composed of five distinct portions: coxa, trochanter, femur, tibia and tarsi. The *coxae*, or haunches, are usually pretty well developed, sometimes, as in the *Papilioninae*, very prominent, serving in their connate obpyramidal form—connate both as regards the opposing and the neighboring pairs—as excellent bases of attachment for the movable parts of the leg; they extend obliquely downward and backward and form a strong support to the hinder part of the thorax, which is the centre of gravity of the whole body. The *trochanters* are inconspicuous small globular masses at the tips of the coxae, carrying the base of the femora a little outward, and serving for greater freedom of motion in all the succeeding parts. The *femora* or thighs are long and slender, straight but somewhat gibbous, compressed, stick-like members, largest near the base, and when in position placed at a very sharp angle with the coxae, which they almost always exceed in length; they are the stronger parts of the movable legs, their gibbous form giving room for a considerable amount of muscular tissue; they are always unarmed, but generally densely clothed with scales and not infrequently with an inferior fringe of long hairs. The *tibiae* or shanks are slender, straight, equal, cylindrical or tetraquetral members,

ordinarily of about the length of the femora but much slenderer than they, and in their natural position placed at a right angle or more than that with the femora; generally clothed with scales, but never fringed with hairs, they are usually armed also with a large number of short spines, ordinarily arranged in longitudinal rows, and particularly upon the sides of the under surface. They are almost always armed at the tip beneath with a pair of much longer spines or spurs, which are themselves sometimes minutely scaled; occasionally in the lowest family the hinder pair is also provided with a second central pair of spurs. In the same family also and in the Papilioninae, the fore tibiae are supplied on the middle of the inner surface with a peculiar leaf-like appendage or epiphysis covered with velvety pile.*

The *tarsi* are composed of five joints, the first usually about as long as the other joints combined, and in the Lycaenidae sometimes swollen in the male sex.† With this exception they are usually slightly slenderer than the tibiae, straight, their combined length usually greater than the tibiae, generally scaled upon at least the upper surface, and in their natural position placed at more than a right angle with the tibiae. Besides being scaled, they are furnished to a greater or less extent, and especially upon the outer edges of the under surface, with a considerable number of short spines, the last joint ordinarily to a less extent than the others; the apical spines, or at least those of the outer row, are prolonged beyond the others to a greater or less degree, and take the nature of spurs. The last joint bears appendages of a special nature at its extremity,—the claws, paronychiae and pulvillus. The *claws* are a pair of horny organs such as the name expresses, usually compressed, curving more or less, and tapering to a point; they are of variable length and divergence, ordinarily simple but sometimes, as in the Pierinae, deeply cleft and bifid. Encircling their base, excepting above, is a fleshy, papillate, tenuous membrane, which very frequently becomes excessively developed at the sides and below the claws, and forms the *paronychiae*, a sort of secondary claws, or whitlows, not so curved as the true claws and merely membranous imitations of them, as it were; occasionally, as in the Pierinae, the portions beside rather than that below the claw are highly developed, and form broad membranous expansions nearly concealing the claws on a side view; often the paronychiae are entirely absent and no trace of any surrounding membrane can be discovered. The *pulvillus* is a sort of foot-pad, which seems to be more or less pedicellate, and the pedicel to originate from between and in front of the base of the claws, at the centre of the fleshy membrane which serves as the foundation of the paronychiae; sometimes the pulvillus seems to be nearly sessile, at

* Haase (Zeitschr. ent., n. f., x: 36) regards this appendage as the relic of an organ formerly developed to clean the antennae by passing the latter between its inner side and the tibia.

† Distant, in mentioning this character in the Indian genus *Gerydus*, calls it a "phenomenal character in *Rhopalocera*"; it is far more common than would appear from that reference, though in *Gerydus* it is unusually prominent.

others the pedicel is half as long as the claws and the pad a long membranous flap, attached to it by one extremity; the pad may take on almost any form, but is usually strongly appressed. Besides these terminal appendages* one or two pairs of long curving hairs, originating just above the base of the claws, arch over and extend far beyond them; this is especially noticeable in the Hesperidae.

The abdomen and its appendages. The abdomen of butterflies is formed of nine segments, the tenth segment of the caterpillar having been dropped with the eremaster of the chrysalis. In general these segments are very similar, but the first is always smaller than the succeeding (as in the chrysalis) and the terminal segments have special modifications according to the sex. Excepting these terminal segments they have no appendages and differ from the same parts in the earlier stages, in that the upper and lower plates of which each somite is made are corneous and distinctly separated by a more or less membranous pleural interspace, within which are situated the spiracles, on the first to the seventh segments only, the spiracle of the eighth segment of the caterpillar having been dropped on the assumption of the pupal condition.† The abdomen is usually compressed to a slight degree, sometimes considerably, and is always as long as, generally longer, sometimes much longer than, the rest of the body, and tapers at both ends.

The posterior portion of the seventh segment of the female is modified beneath to form, in conjunction with the anterior part of the eighth segment, a more or less wide-mouthed vestibule into the upper part of which the vagina opens. The eighth segment in the same sex is much smaller than the preceding, while the ninth is very small and forms merely a compressed pair of short lappets serving as an ovipositor, being internally grooved for the oviduct, and having immediately above that the anal opening.

In the male the seventh segment undergoes no modification, and ordinarily the eighth segment also assumes no special form, but in certain instances it departs from this general rule. Thus, as Burgess first pointed out, the sternal portion of the segment is enormously produced in Euploeinae to form lamellate lappets, which simulate the lateral appendages characteristic of the succeeding segment in butterflies, and so are termed by him "false elaspers"; so also, the median part of the notal piece of the same segment in Pierinae, as the same observer noted, is produced poste-

* A different account of these appendages is given by Burmeister (Lep. Rep. Arg., 18-19).

† This is correlated with and undoubtedly consequent upon the needs of this segment in the female butterfly, the segment being here profoundly modified both externally and internally by the necessities of the vaginal open-

ing. If the eruciform condition of the young be regarded, as morphologists now consider it, as an acquired characteristic, the spiracle of the eighth abdominal segment must be looked on as of late origination, and its frequent lack of alignment with the others and greater size may be more readily explained.

riorly to a curving hook, which in its turn simulates the upper appendage of the succeeding segment. The same is true of the Papilioninae, as Buchanan White has shown, only here it is deeply cleft mesially. A still more singular anomaly occurs in Libytheinae, which in the American *Hypatus* resembles the Pierinae, while in the European *Libythea* it takes more the form of the Papilioninae.

It is in the ninth segment, however, that the greatest variety of form and structure is seen, the segment bearing hinged appendages, serving with the other external armature as *clasping organs*, at the mating season. This apparatus (33-37) may be simply described in general terms as consisting of a median uncate upper organ moving vertically, and paired laminate side pieces or clasps moving laterally. The upper organ (the *sicula* of Rambur, *tegumen* of Buchanan White, *seaphium* of Gosse) is in general a pointed or forked hook, covering the apical organs above and having an upward and downward movement. In its various developments it may be said to consist of a main body or centrum with apical hook or hooks, and curving or bent lateral arms; these latter may be independently developed and conspicuous, as in Satyrinae and Lycaenidae; or soldered to the body or connate beneath the apical hook, and supporting a common inferior armature of prickly points, as in Hesperidae; or developed as mere angular projections, as in Pierinae; or, as in Papilioninae, where the median process of the eighth segment (*uncus* of Gosse) usurps the protecting function of the upper organ, they may form transverse prickly and corrugated ribbons (the homologue of the inferior armature of the Hesperidae) lying near the base of the intromittent organ, which are sometimes torn from their attachments in mating and left in the vestibule of the female (61:48); or finally they may be altogether absent, as in the bulk of the Nymphalinae. The clasps (*valvae* of Rambur) admit of an equal variety of development, but may in general terms be said to be usually composed of a base, with an upper lobe and a blade hardly separable from it, the former usually developing prickly or pointed upper processes (*styles* of Rambur) and hind processes, the latter capable of bearing armature at any point at will, and generally furnished with many stiff bristles near the outer edge. In some of the Lycaeninae, especially the Theclidi, the clasps may be very slightly developed and simple, forming a mere channel for the support of the here enormously developed, apically flaring intromittent organ; or the upper lobe in other cases, as in the Papilioninae, may form a large concealing flap (*valve* of Gosse), and the blade be developed as a curving prickly ridge (*harpes* of Gosse) lying within the valve. The form and sculpture of these appendages varies in every species forming excellent means for their distinction, and they thus become, says Dufour, "the guarantee, the safeguard, of legitimate pairing."

As connected with the outer tegument rather than with the internal organs,

may be mentioned here the glands and similar structures which open externally in butterflies. Allusion has already been made to those which find their outlet through the scales, and probably there are others which find a passage through hairs in various parts of the body — such as in the erect row found on the upper surface of the hind wings of the male *Argynnis*, as in some instances has been proved to be the case in moths. But in some of the higher butterflies, as in our own *Anosia*, we have a protrusile pencil of long hairs (61:49,59), which appear to be cylindrical tubes, lying in sheaths on each side of the eighth abdominal segment of the male; and in an almost precisely equivalent position on the same segment of the female of allied butterflies (*Colaenis*, *Heliconius*, *Eueides*, *Dione*, *Acraea*), Fritz Müller has shown the existence of a pair of protrusile vesicular organs clothed with scales, which are distinctly odoriferous and undoubtedly connected with sexual functions.

The internal organs (Pl. 62: figs. 2-4).

Although the internal organs of butterflies are brought to their full perfection at the close of the pupal condition, and have therefore been already outlined to a certain extent, yet as the account has been coupled with statements of the changes undergone in the larval organization to effect the required result, it may be worth while to give here a succinct account of the completed structures, following the same order as heretofore. The published materials for such a survey, it may be remarked, are exceedingly scanty, and my own dissections have been largely confined to the earlier stages. The only general sketch yet published is that by the indefatigable Léon Dufour (*Comptes rendus*, 1852), but an excellent outline is furnished in his complete anatomy of *Anosia plexippus* (*Anniv. mem. Bost. soc. nat. hist.*) by my gifted friend Edward Burgess, whose loss to entomology is only partially compensated by the gain to scientific naval architecture.

Muscular system. The great mass of the muscular tissue is now developed in the thorax and principally to direct the action of the wings; these muscles form two principal sets: one longitudinal, by far the most numerous, which serve to depress the wings by shortening the thorax; the other a transversely oblique set, attached below to the floor of the thorax, and above to the bases of the complicated structure of the inner frame work of the wing, acting thus at great disadvantage as a lever; besides these a third accessory set running from the scutellum between the other two sets to the front base of the wings, serves to draw them forward. All other muscles of the body serving to move external appendages are attached to the walls of the body in the immediate vicinity of the organ to be moved or to special ridges or inner outgrowths of the walls; while the internal organs may have their independent muscles as in the early stages; some of these will be mentioned in their place.

Digestive system. As a whole, the digestive system is usually somewhat longer than the body, though its convolutions are entirely confined to the intestine proper in the hinder part of the abdomen. Its most peculiar feature in butterflies is the complicated apparatus by means of which the food enters the stomach, the exact method of operation as well as the organic foundation of the same having been discovered and well elucidated by Burgess (87:3,5,9,23). As we shall describe this somewhat in detail in the body of this work, it is only necessary to say here that by means of a highly muscular pharyngeal sac a vacuum is produced within the body, by which the fluids are sucked up the mouth-tube, and are prevented from returning the same way by a simple valve at the anterior extremity of the sac. The sac opens directly into a long and slender oesophagus and the parts that follow show little variation within the whole tribe of butterflies, so far as I have seen, probably due to the great general similarity of their food,—honeyed vegetable secretions or decomposing vegetation. The oesophagus is a perfectly straight and uniform tube extending to the very base of the abdomen. Here, just before it enlarges to form the stomach, it has an independent enlargement of its own, from the upper surface of which the so-called food reservoir (61:46,47,50) takes its rise; this organ, characteristic of Lepidoptera and therefore doubtless connected with its peculiar means of obtaining nourishment (though its actual use is still unknown), is a large, bladder-like, elongated vessel lying upon the stomach in the anterior half of the abdomen, bluntly rounded behind, tapering in front to a rather slender neck, through which it enters the vestibule of the stomach. Cuticular processes (61:36,45), like moistened and therefore tapering pencils of hairs, line the inner surface. The stomach is likewise a straight, cylindrical or fusiform tube, three or four times the diameter of the intestine but still slender, extending through about half of the abdomen, when it contracts to nearly its initial size to form a short, oval, occasionally cylindrical passage, a little larger than the succeeding intestine, into which the malphigian vessels enter. Burgess describes no such chamber separate from the stomach in *Anosia*, into the posterior part of which he makes the malphigian vessels enter; but in *Mancipium*, as figured by Herold, this chylic ventricle is clearly distinct from the stomach and rather forms a part of the intestine. The intestine is a slender cylindrical tube, according to Dufour (who distinguishes the chylic ventricle), swollen at its origin in *Vanessidi* and *Papilionidi*, but uniform in *Anosia* and *Mancipium*; and terminating after its s-shaped curve in a pyriform or cylindrical chamber, the colon, which is simple in *Anosia*, but in others, such as *Mancipium*, provided with an anterior coecal sac. The colon passes insensibly into a slightly tapering rectum, with the anal opening at the extremity of the body.

At the anterior end of the alimentary tract, just beneath the pharyngeal

sac and at the inferior base of the maxillary canal, is the opening of the salivary duct, which is a capillary flexible tube, running backward for only a short distance before dividing into two ducts, passing insensibly into glands of a similar form which are at least half as long as the body, but by reason of the many convolutions as they run beside the oesophagus extending only as far as the base of the abdomen.

As in the early stages of the insect's life, the malpighian vessels are composed of three filiform crinkled tubes on each side of the body, their convolutions overlying the stomach, the ends free, uniting just before entering the chylific ventricle, first one pair and then the third, to form a very short canal.

Respiratory system. According to Dufour the tracheal vessels of butterflies are purely tubular, having none of the vesicular expansions characteristic of the Sphingidae and some other moths, which partake of nourishment while hovering before a flower. The general plan is the same as in the earlier stages, only here the organs are much less bulky, being reduced to exceedingly slender vessels and branching tubes. "The very short main trunk into which the stigmata open soon divides into branches, which run to the special organ to be aerated and there often branch abruptly into a great number of fine tubes . . . The stigmata of the first pair lie in the sides of the prothorax behind the prothoracic lobes" (Burgess). Those of the second pair, not mentioned by Burgess, nor indeed, we believe, by any writer besides Burmeister,* lie just in front of the base of the hind wings, concealed in the suture between the mesothorax and metathorax, at the furthest advance of the latter; they probably belong to the mesothorax, as they and the derivative tracheae adhere to it on forcible rupture of these parts. As Burmeister remarks, the presence of such a pair is surprising, because no spiracles are present here in the caterpillar, though, as we have seen, a spreading bunch of tracheae arise from the longitudinal canal where the spiracle should be expected. Succeeding pairs of stigmata are situated in the pleurae of the first seven abdominal somites, the pair in the first segment being rather hard to find owing to the folds in the integument of its sides.

Circulatory system. The haemal or dorsal vessel, sometimes called the heart, "is a small tube lying immediately under the dorsal wall of the abdomen, and hung in this position by triangular muscular sheets (the alary muscles) which are placed in pairs, apices inwards, on either side . . . The walls . . . contain two sets of muscular fibres running spirally in opposite directions. Slight constrictions divide the heart into a number of segments, corresponding to those of the abdomen. Each segment has probably a pair of clefts for the entrance of the blood . . . In the basal

*Minot and Burgess recognize here in the moth, *Aletia*, "an inconspicuous structure which is perhaps a spiracle."

segment of the abdomen, the heart narrows slightly, making the beginning of the aorta. This after entering the thorax runs upwards, passing between the right and left sets of thoracic muscles, and then under the suture between the mesoscutum and scutellum, and expands rather suddenly into a large [aortal] chamber, which is hung in position by a net-work of fibrous connective tissue. . . . The forward end [of this] bends downwards [sometimes abruptly] and again contracts into a [more or less] slender tube [in Hesperians scarcely slenderer than the aortal chamber, but compressed], which runs backward and downward until it reaches the first part of the aorta, and after passing along the anterior face of this for a short distance, it bends suddenly forward and runs along, and just above, the oesophagus, passing with the latter into the head and through the oesophageal nerve collar" (Burgess). The aorta then divides into several branches, which are lost in the integuments of the head.

Nervous system. A brain, a compound thoracic ganglion, and four abdominal ganglia, lying along the ventral wall of the body and connected by double, often connate commissures, form the base of the nervous system in butterflies.

The brain occupies the centre of the head, immediately over the oesophagus, is laterally bilobate and principally made up of two enormous optic nerves. It furnishes also the antennal nerves and is connected by short cords on either side to a minute frontal ganglion, which gives off posteriorly a recurrent nerve; there are also a pair of posterior, lateral, minute ganglia in the head connected with this recurrent nerve, which innervates the oesophagus and dorsal vessel and with its branches spreads over the stomach. The commissures which extend from the brain backward pass on either side of the oesophagus and immediately before leaving the head unite beneath to form the suboesophageal ganglion; from this arise the nerves which pass to the mouth parts.

The thoracic ganglia are situated in the front part of the mesothorax, and separated by a considerable distance from the ganglia of the head. They are compound, and their compound origin is usually marked to some extent by the form of the mass itself, but they sometimes form a single elongated oval disc. From this arise the crural and alary nerves, or those supplying the legs and wings.

The abdominal ganglia, small round lenticular discs, are always four in number, the first separated from the thoracic ganglion by a distance of nearly half the length of the entire nervous cord, the last compound; they are situated in the third to the sixth abdominal segments respectively and are equidistant. As the cord enters the abdomen, and for the rest of its course, it becomes bordered right and left by a white fibro-muscular membrane, which fixes it to the ventral tegument according to Dufour; and the same writer states that a white ellipsoidal fibrous capsule is embraced

by it at its starting point, at the entrance of the cord into the abdomen, which might easily be taken for a ganglion.

Glandular system. It is stated by authors that a pair of ramose glands is sometimes found in the female butterfly, situated near the orifice of the vagina, "which secrete, perhaps, an odorous substance that excites the copulatory act." They are noted in *Melitaea* and *Argynnis*, and I once described from the dissection of the nearly mature female pupa of *Anosia* "a transverse reniform vessel, attached broadly by its base to the inferior wall of the oviduct at its very extremity," its tip terminating in two little threads. But as Burgess made no note of any such organ, the point requires new dissections to establish it. These glands must not be confounded with those opening externally in the female of some butterflies, noticed above.

Reproductive system. The paired ovaries of the female consist each of four tubular branches which at maturity are longer than the body of the insect, and always so long that they have to run backward and forward, sometimes many times, to accommodate themselves to their narrow quarters, often rolled over and over, but always connected by their united and now solid tips to the upper wall of the abdomen,—in *Anosia* at the fourth segment. From their tips backward the ovarian tubes increase in size and contain each a hundred ovigerous cells more or less, in which the bases of the future eggs lie outward. As they attain their largest the four ovarian tubes unite on each side to form an oviduct, and the two oviducts shortly afterwards unite to form a common duct, the oviduct proper, which is the common receptacle of all the special accessory organs, and itself is often enlarged in some *Lepidoptera* to form a point of arrest for the eggs while they are prepared for future needs. The most important of the organs tributary to the oviduct are those which enter it near the middle by the sperm duct—a slender tube connected directly with a vesicular sac, the spermatheca, which by a similar tube at its opposite extremity is joined to the large, long-oval, bladder-like, but muscular capsule, the copulatory pouch; this conducts by a larger tube or curved canal, the vagina, into the vestibule on the under surface of the seventh and eighth segments. There also enter the oviduct two sets of accessory glands, one single, morphologically the mate of the spermatheca and the smaller, the other set paired, and all consisting first of filiform secretory vessels, next of a reservoir and last of a short excretory duct which opens into the oviduct; their function is supposed to be connected with the final preparation of the egg wall and its varnish-like coating. The ovipositor is formed of the lateral lamellae of the ninth segment.

The male organs consist of a single large globular testis, compound in origin but now simple in structure and homogeneous, often highly colored, rose, green or purple, mesially situated in the fifth abdominal segment (or just about the centre of the abdomen) above the stomach. It is retained

in place and supported by the tracheae of this segment. Close together, a pair of efferent ducts arise from the posterior walls of the testis, simple tubes which conduct to two long filiform seminal vesicles near the base of the latter; these last soon unite to form the ejaculatory canal, the single, slender, excessively elongated duct for all this apparatus, which being many times, generally from three to five times, longer than the body of the insect requires for its accommodation to be rolled into the most complicated convoluted mass imaginable. The duct ends in the intromittent organ, a corneous hollow needle, often expanded apically and always furnished with a bulbous base. Special muscles attached to the posterior walls of the last segment arrange for its forcible ejection.

II.

THE MODERN CLASSIFICATION OF BUTTERFLIES, HISTORICALLY CONSIDERED.

"Worship not me, but God!" the angels urge:
That is love's grandeur: still, in pettier love
The nice eye can distinguish grade and grade.
Shall mine degrade the velvet green and puce
Of caterpillar, palmer-worm—or what—
Ball in and out of ball, each ball with brush
Of Venus' eye-fringe round the turquoise egg
That nestles soft,—compare such paragon
With any scarabæus of the brood
That, born to fly, keeps wing in wing-case, walks
Persistently a-trundling dung on earth?
BROWNING.—*Red Cotton Night-Cap Country.*

That the families of butterflies rank higher than those of other Lepidoptera is universally conceded and susceptible of proof. Every part of their organization when considered comparatively shows a movement from the lowest moths to the higher butterflies. Agassiz pointed out that in the lower families as a general rule (not without its abundant exceptions) the wings in repose are inclined from each other like the sides of a roof, closely resembling the position they occupy during the earlier and therefore inferior pupal state; while in nearly all butterflies and notably in the higher ones, the wings are held erect, back to back, as far removed as possible from their location in the chrysalis. But this view is assuredly fanciful, since the position of the wings during their still earlier larval condition resembles that of the butterflies much more than it does that of the moths!

In reality we are dealing here with families in a suborder and can scarcely expect to find the well-marked signs of relative rank which attach more strongly to the larger divisions into which a class is divided; among families, rank is subordinated to characteristics more peculiarly attaching to the nature of the group; but by tracing out the development of certain features of the order, we find ourselves travelling in a path in which new

characters appear and aggrandize, while others diminish and finally fade ; and thus it is that we can follow out the relative rank of its members with a considerable degree of satisfaction, and discover a series culminating in the families of butterflies ; the considerations which will be brought forward in discussing the relative position of the separate families will continually throw light upon this view and we need not discuss it further in this place, but proceed to an examination of the views of authors concerning the primary divisions of butterflies.

From 1758 to 1815. The first effort at the classification of butterflies was made by Linné in the tenth edition of the *Systema naturae* (1758) ; his scheme is as follows :—

a. Equites.	c. Danai.	d. Nymphales.	e. Plebeii.
Trojani.	candidi.	gemmati.	rurales.
Achivi.	festivi.	phalerati.	urbicolae.
b. Heliconii.			f. Bastardi.

Here the Papilionidae are placed highest. Their division into two groups is merely a fanciful one, depending on the presence or absence of red spots. The last group comprises only forms whose proper location was a puzzle and from which they could be drawn and distributed properly as they became better known, and may therefore be left out of consideration. With this exception the Hesperidae are placed lowest, as they have been by every subsequent author, for their close relationship to the lower families of Lepidoptera leaves no doubt whatever concerning their true position ; but with them Linné placed the great group of Lycaenidae, with which they have but comparatively distant connection. The Heliconii were founded upon a few strange looking, dark-spotted, white butterflies now placed in the genera *Doritis* and *Parnassius*. The Danai formed a heterogeneous group, although each of its divisions is in itself mainly natural, the *D. candidi* belonging properly with the previous group and the *D. festivi* corresponding to Euploeinae and its allies. The group Nymphales would have been a natural one had the Danai festivi been added to it, but its divisions, based on the presence or absence of ocellate spots on the wings, was utterly without value.

In his *Fauna Suecica* (1761), Linné had already made alterations in his plan of divisions, the whole of the Danai candidi being merged with the Heliconii, which would thus have formed a natural group had not some of the Satyridae been also included in it, while others were left as before in the Nymphales ; but in the twelfth edition of the *Systema naturae* (1767), the old system was restored.

In 1762, Geoffroy, in his *Histoire des insectes aux environs de Paris*, proposed a new scheme of classification in which his primary groups were founded upon the character of the fore legs, to which I believe Réaumur first drew attention ; but he did not fail to recognize other distinctions also,

and was the first to perceive the value of characters drawn from all the stages; the following is his division:—

I. With four legs (front legs without claws, having often the appearance of a tippet,—“palatine”).

1. Caterpillars spiny, wings angular.
2. “ “ wings rounded.
3. “ smooth; fore legs short but not tippet-like.

II. With six legs (all the legs furnished with claws. Chrysalids horizontal, girt around the middle with a thread).

The first division comprises the Nymphalidae; its first two subdivisions corresponding to the Vanessidi and Nymphalidi, the third to the Euploeinae and Satyrinae. This was more natural than Linné’s divisions, and Geoffroy was also the first to recognize the superiority of the Nymphalidae.

De Geer (1771) divided butterflies into five families, but he reversed the order of Geoffroy, placing the butterflies with perfect fore legs above those in which they were atrophied. None of his families were named; they were as follows:—

- I. Six legs. Wings embracing under surface of abdomen.
- II. Six legs. Wings embracing upper surface of abdomen.
- III. Six legs. Wings inclined backward.
- IV. Four legs. Fore legs hanging like a tippet [= Nymphalidae excl. some Satyrinae].
- V. Four legs. Fore legs very small and short [= some Satyrinae].

In the year 1775 appeared a very remarkable anonymous work on the Lepidoptera of the vicinity of Vienna (*Systematisches verzeichniss der schmetterlinge der Wienergegend*) in which the character of the larvae formed the basis of the classification. Instead of recognizing the authors, Messrs. Denis and Schiffermüller, it is generally known as the Vienna Catalogue. This is the division proposed therein:—

- | | |
|---|---------------------------------------|
| A. Larvae tortriciformes [Hesperiidae]. | I. Larvae acutospinosae [Vanessidi]. |
| B. “ bombyciformes [Doritis]. | K. “ collospinosae [Argynnidi]. |
| C. “ variegatae [Papilionidi]. | L. “ pseudospinosae [Melitaeidi]. |
| D. “ mediotriatae [Pieridi]. | |
| E. “ pallidiventres [Rhodoceri]. | <i>Onisciformes.</i> |
| F. “ subfuscae [Satyrinae]. | M. “ oblongoscutatae [Chrysophanidi]. |
| G. “ cornutae [Apaturidi]. | N. “ gibbososcutatae [Lycaenidi]. |
| H. “ subspinosae [Nymphalidi]. | O. “ depressoscutatae [Theclidi]. |

An examination of this scheme (to the members of which modern names are attached in brackets) will show that nearly all the principle groups of butterflies found in Europe are recognized in it and most of them for the first time. With the exception of the position of the onisciform caterpillars the general order is almost faultless. Had subsequent authors paid as much attention as these writers to the characters presented by the earlier stages our knowledge of their natural relations would have made better progress.

Scopoli in 1777 divided the species catalogued by Linné in the tenth edition of the *Systema naturae* into six genera, all them heterogeneous, being founded wholly on superficial characters, in which he certainly had

some warrant in the practice of Linné. Owing probably to their mixed character, these generic names have not been brought into general use.

Borkhausen, the writer of the first distinctive work on European butterflies (1788), was the first to improve upon the classification of Linné by characters drawn from the perfect insect. The following represents his classification :

1st Horde, Nymphae.	4th Horde, Danai [Pierinae].
Najades [Vanessidi and Nym- phalidi].	5th Horde, Plebeii rurales [Lycaeninae].
Dryades [Argynnid].	Papiliones subcaudati [Theclidi].
Hamadryades [Melitaeidi].	Pap. rutili [Chrysophanidi].
Oreades [Satyrinae].	Pap. polyophthalmi [Lycaenidi].
2d Horde, Equites [Papilionidi].	6th Horde, Plebeii urbicolae [Hesperiadae].
3d Horde, Heliconii [Parnassidi].	

Borkhausen was the first author after Geoffroy to recognize the superiority of the Nymphalidae, which he divided into groups already separated in the Vienna Catalogue. At the same time he places the “Danaï festivi” where they belong, with the “Nymphae.” Following still further the divisions of Denis and Schiffermüller, he divides the “Plebeii rurales” into three groups, which are wholly natural. Had he simply placed his fifth horde next to the first, he would have shown a series leaving little room for improvement.

In his earlier works from 1775 to 1787 Fabricius followed closely the divisions of his master Linné. In his *Entomologia systematica* (1793), he seems to have paid no attention to this classification by Borkhausen, although he alters, but scarcely for the better, the system used by himself in his earlier works, as will be seen by the following abstract :

Genus Papilio.		Danaï [former Danaï candidi].
Equites.	Nymphales.	
Trojani.	Heliconii.	Satyri.
Achivi.	Parnassii [former Heli- conii].	Genus Hesperia.
Festivi [Danaï festivi of previous works].		Rurales.
		Urbicolae.

Besides the introduction of a new generic name to distinguish the smaller butterflies, he has separated the Oreades of Borkhausen from the group in which they were formerly combined under the new name of Satyri, a name which in various forms has since been used in preference to the earlier one of Borkhausen ; and that, although the actual scientific worth of Fabricius's system is far inferior to that of Borkhausen. He has also introduced the new term Parnassii for the Heliconii of his former works, and given the latter name to the exotic forms usually known since under that title. Besides these vagaries he altered the sequence of the groups much for the worse, as a comparison of the two will instantly show.

In the same and following years Herbst, in the sixth to the ninth volumes of his general work, proposes still another classification, in which a number of new names are introduced, most of them in connection with natural

groups, but arranged in a most irregular manner as appears from the following abstract which hardly needs discussion :—

Consules [miscellaneous Nymphalidae] ; Nobiles [miscellaneous Nymphalinae] ; Tribuni [Euploeinae] ; Praefecti [Vanessidi] ; Praetores [some Satyrinae] ; Vestales [Lemoniinae] ; Archontes [Apaturidi, Vanessidi, etc.] ; Dictatores [some Satyrinae] ; Milites [Argynni and Melitacidi] ; Ephori [Theclidi] ; Cives [Lycaenidi] ; Rustici [Hesperidae].

In 1798 Cuvier in his *Tableau élémentaire* divided butterflies into the two Fabrician genera *Papilio* and *Hesperia*, and the first of them into the following groups : *Nymphales*, *Danai*, *Parnassii*, *Heliconii*, *Equites*, *Plebei*. These names correspond to their later use by Fabricius but are arranged in a more natural order and with the omission of several employed in the *Entomologia systematica*.

In 1801 we come to the second faunal work which treats of butterflies, Schrank's *Fauna Boica*, and in this we find, as in Borkhausen, a much clearer appreciation of natural relationships. The butterflies of his district were grouped into five genera, which were again subdivided into lettered tribes to which no names are given ; they are as follows :—

Erynnis [Hesperidae].	Maniola.	C [Argynni].
Pieris.	A [Satyrinae].	D [Melitacidi].
A ["Heliconii"].	B Apaturidi].	Cupido.
B ["Equites"].	Papilio.	A [Chrysophanidi].
C [Pieridi].	A [Nymphalidi].	B [Lycaenidi].
D [Rhodoceri].	B [Vanessidi].	C [Theclidi].

It will be seen in the first place that Schrank follows precisely the order of the Vienna Catalogue ; and next that he limits the genus *Papilio* to the Nymphalidae and ignores Fabricius's genus *Hesperia*, which is equivalent to his own *Erynnis* and *Cupido* combined ; these he has strangely separated at the widest extremes ; had his genus *Cupido* been placed between his *Pieris* and *Maniola*, little objection could be made to his arrangement ; as it is, it remains of about equal value with that of Borkhausen, although more fully freed from the injurious influence of the earlier authors.

Latreille in Sonnini's *Buffon* (1805) first introduced a distinctive family name, *Papilionides*, for all butterflies. His division into genera is as follows :

<i>Nymphalis</i> .	<i>Danaida</i> [Euploeinae].
<i>Nymphales</i> prop. dict.	<i>Papilio</i> [Papilionidi].
[Nymphalidi Vanessidi, etc.].	<i>Parnassius</i> [Parnassidi].
<i>Perlati</i> [Argynni and Melitacidi].	<i>Pieris</i> [Pierinae].
<i>Satyri</i> [Satyrinae].	<i>Polyommatus</i> [Lycaeninae].
<i>Heliconius</i> .	<i>Hesperia</i> [Hesperidae].

The serial value of this arrangement is an improvement upon that of Schrank, although *Polyommatus* is placed again in close connection with *Hesperia*, as was first done by Linné. Generic names are for the first time applied to the principal divisions of Fabricius.

At the time of his death, Fabricius had in press a general *Systema glossatorum*, but only the unpublished proof-sheets remain, an abstract, however, was given in Illiger's magazine (1807) in which the butterflies were divided into forty-one genera, but no higher divisions were proposed. The sequence of his genera, however, shows that he had scarcely altered his former serial arrangement, and such changes as he did introduce were not for the better.

Latreille made changes in classification in nearly all his numerous works, so that it is necessary to follow him closely. In his *Genera crustaceorum et insectorum* (1809) he divided butterflies into two families, *Papilionides* and *Hesperides*, including in the latter only the *Hesperiidae* of modern authors, with two genera, one of which has since been separated from the butterflies; the first family included eleven genera, extensively divided into unnamed sections, to which he attempted to refer the Fabrician genera. The series began with the *Nymphalidae*, of which he first placed the "Satyri" at the head and continued with *Cethosia*, *Heliconius* and *Danaus*; following with *Papilio*, *Parnassius* and *Colias*, it closed with *Erycina* and *Polyommatus*, one representing the *Lemoniinae* the other the *Lycaeninae*. The general arrangement, therefore, does not differ from that of his earlier work nor from that of Cuvier's *Tableau*.

In the following year however (*Considérations générales*) he changed the relative position of these genera of *Papilionides* materially, but not for the better. Beginning with the genera of *Papilionidae* he continued with those of *Pierinae* and then of the *Euploeinae*; after this followed those of the *Nymphalinae* and *Satyrinae*, and finally, as before, those of the *Lycaenidae*.

Leach was the first English author who attempted a careful classification of butterflies; in the *Edinburgh Encyclopaedia* (1815) he published the following scheme, for his *Section Diurna* :—

Tribe I. *Papilionides*.

Fam. 1. *Papilionida* [*Papilio*, *Parnassius*, *Pieris*, *Colias*, *Gonepteryx*, *Argynnis*, *Melitaea*, *Vanessa*, *Hipparchia*, *Limenitis*, *Apatura*].

Fam. 2. *Lycaenida* [*Thecla*, *Lycaena*].

Tribe II. *Hesperides*.

Fam. 1. *Uranida*.

" 2. *Hesperida*.

The general sequence of genera given in Latreille's then last published work was followed and the opposition of the skippers to the other butterflies still maintained, but the butterflies with onisciform larvae were first recognized as a family group.

Another entirely new and peculiar classification was attempted by Hübner somewhere between 1806 and 1810* in his much discussed *Tentamen*, in which *Phalanx I. Papiliones* was divided as follows :—

*Hübner states, in the first century of his *Zuträge* (1818), that it was published in 1806,

and I have so quoted it, where necessary, in this work.

Tribus I. *Nymphales*.

- I. Nereides [Heliconinae].
- II. Limnades [Euploecinae].
- III. Lemniades [Melitacidi]—reticulati.
- IV. Dryades [Argynniidi]—ornati.
- V. Hamadryades [Vanessidi]—undulati.
- VI. Najades [Nymphalidi]—fasciati.
- VII. Potamides [Apaturidi]—phalerati.
- VIII. Oreades [Satyrinae]—gemmati.

Tribus II. *Gentiles*.—Gens.

- I. Rustici [Lycaeninae]—rurales.
- II. Principes [Papilioninae]—nobiles.
- III. Mancipia [Pierinae]—vulgares.
- IV. Consules [Libytheinae]—consules.
- V. Urbani [Hesperidae]—civiles.

The same general scheme, with only the change of names I have indicated above after the dashes, was used by Hübner throughout his *European Butterflies*, published from 1806 until his death. The influence of Borkhausen is plainly seen in the nomenclature, but in the separation of the Nymphalidae as a group of equivalent value to the rest of the butterflies this scheme is unique. The Tentamen has, however, been completely overlooked by later writers, though copied in principal by Ochsenheimer, as will be seen shortly.

From 1816 to 1836. The year 1816 gave birth to no less than three distinct works of importance upon butterflies. The first in merit was that of Dalman, who published in the Swedish Academy's memoirs an essay upon the classification of the butterflies of Sweden; in his definitions of the groups, both of large and minor extent, he has brought into use the most essential characters, drawn not only from the imago but from the larval and pupal states, treating his subject in a manner more thoroughly scientific than had ever been previously done. I subjoin in full at the top of the next page the table which preceded his full characterization of the groups, as it presents the divisions of the author in a succinct form, and shows the progress that had been made at that time by the best naturalists. It will be noticed that while the sequence of the groups is similar to that given in Latreille's earliest essay, the germs of several of the larger divisions of later times are here first brought to light.

The second work, published in the year 1816, to which we would call attention, is the fourth volume of Ochsenheimer's *European butterflies*. In his previous volumes, as in his *Schmetterlinge Sachsens* (1805), the author had placed all the species under the genus *Papilio*; now he divides them without further classification into sixteen genera, arranged in the following order: *Melitaea*, *Argynnis*, *Euploea*, *Vanessa*, *Limenitis*, *Charaxes*, *Apatura*, *Hipparchia*, *Lycaena*, *Papilio*, *Zerynthia*, *Doritis*, *Pontia*, *Colias*, *Hecarge*, *Hesperia*. Notwithstanding his criticism of Hübner in the preface, it will be seen that the sequence here, with the sole exception of the position of *Euploea*, is exactly the same as Hübner outlined a few years before, and was then employing in his iconographic works.

Finally the third work of this year was a more elaborate classification, published by Hübner in his *Systematisches verzeichniss*, an expansion of

Tabula synoptica Lepidopterorum diurnorum Sveciae Familias, Sectiones et Phalanges sistens.

Ordo Lepidoptera. Tribus I. Diurna. (Antennae extorsum crassiores. Stemmata nulla. Alae liberae, retinaculo nullo. Alae insecti quiescentis erectae.)	Familia I. <i>Papiliones</i> . Tibiae posticae muticae apice solo spinoso l. calcarato. (Larva subdialis).	Sectio I. Tetrapodes. Pedes gressorii tantum 4, antici duo abbreviati debiles.	Phalanx I. Tetrapodes. <i>Alae</i> posteriores abdomen subtus canali excipientes. <i>Puppa</i> subversa, ano tantum suspensa. <i>Larva</i> plus minusve spinosa l. saltem ano bimucronato.	Divisio I. <i>Alae</i> posteriores areola aperta. (Nervorum trunci 2, anterior nervos 2, 3, 4; posterior 5, 6, 7, emittens). <i>Larva</i> plus minusve spinosa.	Genera. 1. Limonitis. 2. Aglais. 3. Argynnis. 4. Melitaea.
		Sectio II. Hexapodes. Pedes omnes completi gressorii.	Phalanx II. Hexapodes. <i>Alae</i> posteriores pro abdomine libero margine interiore excisae, nervis tantum 8; primo et octavo e basi alae, reliquis ex areola clausa orientibus. <i>Larva</i> tentaculo collare bifido, carnoso, retractili.	Divisio II. <i>Alae</i> posteriores areola clausa, nervos radiatim emittente. <i>Larva</i> nuda, ano bimucronato.	5. Erebia.
			Phalanx III. Hexapodes. <i>Alae</i> posteriores abdomen canali excipientes, nervis novem. <i>Puppa</i> antice unimucronata, filo transverso alligata. <i>Larva</i> mutica.		6. Amaryssus. 7. Doritis.
			Phalanx IV. Hexapodes. Corpus statura parva gracili. <i>Alae</i> posteriores abdomen canali excipientes; areola aperta; nervi novem. Oculi margine palpebrali distincto, niveo. <i>Larva</i> onisciformis, subovata, mutica, subtus plana; capite parvo, pedibus obsoletioribus. <i>Puppa</i> brevis obtusa, filo per medium alligata.		8. Ganoris. — Colias.
	Familia II. <i>Hesperides</i> . Tibiae posticae praeter apicis calcaria spina gemina et infera instructae, antice latere interno apicem versus excavato; fossula appendicem spiniformem excipiente. (Ut in Familiis sequentibus Lepidopterorum Crespusculariorum et Nocturnorum quibus haec Familia viam parat.				9. Zephyrus. — Aurotis. — Heodes. — Cyaniris.
					10. Hesperia.

his preceding attempts, in which the Phalanx Papiliones was divided as follows :—

Tribus *Nymphales*.

- Stirps 1. Nereides [Heliconinae].
2. Limnades [Euploeinae].
3. Napaeae [Lemoniinae].
4. Lemoniades [Melitaeidi and Acraeidi].
5. Dryades [Argynniidi].
6. Hamadryades [Vanessidi].
7. Najades [Nymphalidi].
8. Potamides [Apaturidi].
9. Oreades [Satyrinae].

Tribus *Gentiles*.

- Stirps 1. Agrodiaeti [Lycaeninae].
2. Archontes [Papilioninae].
3. Andropoda [Pierinae].
4. Hypati [Libytheinae].
5. Telchines [Castniidae].
6. Astyci [Hesperidae].

In this scheme many of the names of Borkhausen, seldom noticed, have been misapplied. It differs from that of the author's European butterflies

in the introduction of the first three stirps, exotic groups omitted in the latter; the Lemoniinae have a strange place assigned them; it was undoubtedly the character of the larva, with which he was acquainted, which induced him to place the Libytheinae next the Pierinae. In these schemes Hübner is the first to place the Nymphalidae (in general) in opposition to all the rest of the butterflies.

The last mentioned work of Hübner is more remarkable for its minute division of the genera than for anything else; this division is founded mainly upon appearances and patterns of coloration,—a significant and helpful but unsafe guide, by which he has been led into a great number of errors; yet it is safe to say that he had arrived at that early day at a clearer idea of the minuter relationship among butterflies than almost any one since his time; and as only about seventy genera of butterflies had been established previously to the publication of his work, while he refers them to more than four times as many generic groups (under the designation *Verein* or *Coitus**), it is plain that a considerable portion of the names now in use must perforce be referred to Hübner. Yet this is not all, for each one of his fifteen stirps was divided into families, sixty-two in number in all, which in connection with his stirps formed the compound generic designations of his earlier works, designations to which, strange to say, he himself returned six years later in his list of European butterflies.

To return to the classification of Latreille as altered in his various works: in the first edition of the *Règne animal* of Cuvier (1817), all the species were classed again under one genus, *Papilio*, which was divided into several subgenera arranged in much the same order as in his *Genera Crustaceorum et Insectorum*, but without any larger groups.

In the *Encyclopédie méthodique* (1819) the order of the *Considérations générales* was exactly followed with the introduction of a few new genera; the families, however, were designated “tribes,” and a more minute subdivision made; among other things, doubtless from the influence of Leach, the *Lycaenidae* were separated from the other *Papilionides* as a distinct division, but without name.

In his *Familles naturelles* (1825) he retains nearly the same sequence of genera, excepting in placing *Libythea* nearer its true allies. The tribe of *Papilionides* is, however, divided into two great groups, *Hexapoda* and *Tetrapoda* (although the latter term is not directly employed) and the latter are again divided into two unnamed groups corresponding to *Nymphalidae* and *Lycaenidae*; within the former of these last two, other large groups are recognized, as will be seen by the following general abstract of his scheme, under the Family *Diurna*:—

*Hübner employed the term “genera” for the species, and gave either new collective

terms to all the other categories, or new applications to old terms.

Tribe *Papilionides*.

Hexapoda.

A. *Papilio*, *Parnassius*, *Thais*.B. *Colias*, *Pieris*.

[Tetrapoda].

I. A. *Danaïda*, *Idea*, *Heliconia*, *Acraea*.

B.

a.

* *Perlata* (*Cethosia*, *Argynnis*).

**

† *Vanessa*.†† *Libythea*, *Biblis*, *Nymphalis*, *Morpho*.b. *Pavonia*, *Brassolis*, *Eurybia*, *Satyrus*.II. *Argus*.1. *Myrina*, *Polyommatus*, *Erycina*.2. *Barbicornis*, *Zephyrus*.Tribe *Hesperides* (*Hesperia*, *Urania*).

Finally, in the second edition of Cuvier's *Règne animal* (1829), he observed the same order without employing any large groups, considering the names formerly used as subgenera under one genus, *Papilio*.

In 1823, Duméril divided the *Globulicornes* or *Ropalocères* as he called the butterflies into three genera, *Papilio*, *Hesperia* and *Heteropterus*.

In 1828, Horsfield, thoroughly imbued with the somewhat fanciful views of MacLeay upon the classification of animals into quinary groups, proposed to divide the butterflies, or the "Tribe Papiliones" into five stirps called respectively :—

Vermiform stirps [*Lycaeninae*].Chilognathiform or Juliform stirps [*Papilionidae*].Chilopodiform or Scolopendriform stirps [*Nymphalidae*, excepting next group].Thysanuriform stirps [*Satyrinae*, *Apaturidi*].Anopluriform stirps [*Hesperidae*, *Lemoniinae*].

The construction of a special group equivalent to either of the others for those butterflies whose larvae have a forked tail is too unreasonable, with our present knowledge of butterflies, to admit of a single thought. But some excellent remarks will be found in the work, especially in praise of the Wiener Verzeichniss.

The quinary system of MacLeay also gained a voluble adherent in Swainson, who in the previous year (*Phil. mag.*) had asserted that "where we find the series of any particular group unbroken by sudden or abrupt transitions, it will always be found to contain five others of an inferior description, two of which will exhibit a perfection superior to the other three." Accordingly he proposed the following main division of butterflies :

typical {	{ <i>Nymphalidae</i> . <i>Papilionidae</i> .	aberrant {	{ <i>Hesperidae</i> . <i>Polyommata</i> . <i>Heliconidae</i> .
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As these were not supposed to indicate a serial but only a circular arrangement, the *Heliconidae* being regarded as as near to the *Nymphalidae* as to the *Polyommata*, it was a clever attempt by one holding mathematical views akin to squaring the circle. In his subsequent essays, however, as

in his Zoological Illustrations, he alters the names of his groups and employs so many new family names—as Satyridae and Erycinidae—that it would seem as if his views were not fixed with any mathematical rigidity.

Stephens, also, accepting the principal that “natural objects cannot be arranged agreeably to their affinities, otherwise than by a series of circles returning . . . into themselves,” although “sceptical as to the quinary arrangement being universal,” proposed in his Catalogue of 1829 four families of butterflies arranged thus :—

- | | |
|--------------------|-------------------|
| [1.] Papilionidae. | [2.] Nymphalidae. |
| [4.] Hesperidae. | [3.] Lycaenidae. |

In his serial list the order is given as I have numbered them.

Boisduval is the next author to whom we must turn our attention. In his *Index methodicus* (1829) he divided the “Diurni” into three tribes, Papilionidi, Nymphalidi, and Hesperidi. No further subdivisions were offered excepting genera. The Lycaeninae were all placed in *Polyommatus* at the end of the first tribe. In the arrangement of the larger groups, then, this scheme has nothing that is natural excepting its termination with the “Hesperidi,” as all authors have done; it places the very highest and very lowest butterflies in juxtaposition, and is founded, though not expressly, on characters drawn from the pupa only.

In his *Species général*, this same author gives a historical account of classifications proposed up to his time, which is full of the most extraordinary errors, and which ends with still another arrangement, differing from all preceding in the multiplication of groups called by him families, which are classed as above into three groups founded expressly on the mode of suspension in the pupa.

Succincti (Papillonides, Pierides, Eumenides, Lyceides, Erycinides, Peridromides).

Suspensi (Danaides, Heliconides, Nymphalides, Brassolides, Morphides, Satyrides, Biblides, Libythides).

Involuti (Hesperides).

This, it will be seen, is but a development of his former views, expressed in the *Index* and subsequently in his work on American butterflies with LeConte (1829-34), as well as in his *Ieones* (1832-43) in which the groups *Succincti* and *Suspensi* or *Pendulae* are first introduced. It is the order adopted by a very large class of entomologists at the present day, and has the demerit of all classifications established on single characters; fortunately, within a few years, the sounder opinions of previous writers are beginning to gain supporters, and to be established upon still more substantial grounds.

From 1839-1859. The first step in this direction was taken by Westwood, in his *Modern classification of insects* (1839), not only with regard to the arrangement of the primary groups, but in opposition to the introduc-

tion of so many minor divisions, to which an equivalent rank was accorded, that of families. Westwood divided the butterflies into six families in the following order: Papilionidae, Heliconidae, Nymphalidae, Erycinidae, Lycaenidae, and Hesperidae; the Papilionidae were further divided into two groups. Excepting in the abnormal position of the Papilionidae, a legacy from many previous systems, the sequence of the groups leaves little to be desired.

In their *Histoire naturelle des insectes* (1840), Messrs. Blanchard and Brullé adopted most of the groups founded by Boisduval, but considered them as subfamilies or tribes; they arranged them also into four families whose sequence differs a little from that proposed by Boisduval, thus:

Fam. *Papilloniens*; tribes, Papillonites, Pierites.

Fam. *Nymphaliens*; tribes, Peridromites, Danaïtes, Heliconites, Argynnites, Biblites, Libytheites, Nymphalites, Brassolites, Morphites, Satyrites.

Fam. *Eryciniens*; tribes, Lycaenites, Erycinites.

Fam. *Hesperiens*; tribe Hesperites.

Duponchel in his *Catalogue méthodique* (1844) divided the "Diurna" into thirteen tribes with no intervening groups. They are placed in the following order: Danaidae, Argynnidae, Vanessidae, Libytheidae, Nymphalidae, Satyridae, Papilionidae, Parnassidae, Pieridae, Rhodoceridae, Lycaenidae, Erycinidae, Hesperidae. Here again for the first time, for many years, the nymphalid groups are placed above the others, but the Lycaenidae and Erycinidae are still placed next the Hesperidae. It resembles the arrangement by Latreille in Sonnini's Buffon.

In 1848 began the publication of the great work of Messrs. Doubleday and Hewitson on the Genera of butterflies, continued by Westwood in the place of Doubleday after the death of the latter. As Westwood frequently expresses his dissent from the classification of the larger groups adopted in the latter half of the work, and states that he has endeavored simply to complete the work as entirely as possible in accordance with the views of his predecessor, we must speak of the general classification as throughout that of Doubleday. In this classical work Doubleday divided the butterflies into numerous families without the intervention of larger groups or the use of subfamilies; his families are as follows: Papilionidae, Pieridae, Ageronidae, Danaidae, Heliconidae, Acraeidae, Nymphalidae, Morphidae, Brassolidae, Satyridae, Libytheidae, Eurytelidae, Erycinidae, Lycaenidae, Hesperidae. The Nymphalidae are thus broken up into an unusual number of groups, each of which is considered of family value and equivalent to such large assemblages as the Lycaenidae or Hesperidae.

Stephens's arrangement as given in the British Museum Catalogue of English insects (1850) is as follows:—

Fam. *Papilionidae*; subfamilies, Papilionidi, Rhodoceridi, Pieridi.

Fam. *Nymphalidae*; subfamilies, Satyridi, Nymphalidi, Vanessidi, Argynnidi.

Fam. *Erycinidae*.

Fam. *Lycaenidae*.

Fam. *Hesperidae*.

The only thing to be noticed in this arrangement, when compared with its recent predecessors, is the high rank accorded to the Satyridi; no sub-families were admitted among the Nymphalidae in his previous catalogue, nor were the Satyrinae placed at the head of the Nymphalidae.

Heydenreich in 1851 published a catalogue of European Lepidoptera in which there was no higher division of the butterflies than genera and these followed the order of Ochseneimer.

Lederer in his attempt at a serial distribution of European butterflies (Verhandl. zool.-bot. Ver. Wien, 1852) employed nine families, placing Equites, Pierides, Lycaenoidae and Erycinides under Succincti; Libytheoidae, Nymphalides, Danaides and Satyroidae under Pendulae; and closing with the Hesperoidae. The influence of Boisduval is marked.

In his Scandinavian butterflies (1853), Wallengren has introduced a new arrangement, in which Dalman's principal divisions are recognized. The butterflies are first divided into two families, Papiliones and Hesperoidae, and the former subdivided thus:—

Sect. I. <i>Tetrapodes</i> .	Tribe IV. Parnasii.
Tribe I. Satyroidae.	V. Equites [Papilionidi].
II. Nymphalides.	VI. Lycaenoidae.
Sect. II. <i>Hexapodes</i> .	Sect. III. <i>Heteropodes</i> .
Tribe III. Heliconides [Pierinae].	Tribe VII. Erycinides.

It is evident that he has been carried too far in his valuation of the structure of the fore legs when he unites the Lycaenoidae with the other Hexapoda in distinction from the Erycinides. Nor is any reason given why the Heteropodes would not be in their logical position between the other two sections.

Lucas in Chenu's Encyclopédie (1853) published an abstract of the genera given by Doubleday and Westwood, altering somewhat the disposition of the groups, as the following table will show:—

Fam. <i>Papilionii</i> .	Tribe Nymphalidae.	Div. Biblitae.
" <i>Nymphalii</i> .	Div. Argynitae.	" Satyritae.
Tribe Ageronidae.	" Nymphalitae.	Fam. <i>Erycinii</i> .
" Danaidae.	" Morphitae.	Sect. Lycaenitae.
" Heliconidae.	" Brassolitae.	" Erycinitae.
" Acreidae.	" Libytheitae.	Fam. <i>Hesperii</i> .

In 1854, Bruant, like Wallengren, proposed to separate the Nymphalidae from the rest of the butterflies on account of the structure of the fore legs; the following is his classification:—

Div. I. Four ambulatory legs.	Tribus 4. Polyommataidae.
Tribus 1. Satyridae.	" 5. Pieridae.
" 2. Nymphalidae.	" 6. Parnassidae.
" 3. Argynnides.	" 7. Papilionidae.
Div. II. Six ambulatory legs.	" 8. Hesperidae.

Perhaps the most peculiar characteristic of this arrangement is the unequal value of the tribes, but in the sequence it is a clear improvement upon Wallengren's scheme.

Heinemann's useful and well digested work on the Lepidoptera of Germany and Switzerland (1859) arranged the butterflies in eight families in the following order:—Satyridae, Nymphalidae, Libytheidae, Erycinidae, Polyommataidae, Equitidae, Pieridae and Hesperidae; an excellent scheme which showed that the influence of their earlier students had not forsaken Germany.

From 1861 to 1886. The reaction from a classification dividing butterflies into a great number of groups to which equal value was accorded, seems to have begun with Bates, who, in 1861 (*Journ. ent.*) proposed the following arrangement, in which it will also be noticed that the Papilionidae are placed low in the scale, as by Bruant and Heinemann.

Fam. <i>Nymphalidae</i> .	Fam. <i>Erycinidae</i> .
Subfam. <i>Acraeinae</i> .	Subfam. <i>Libytheinae</i> .
“ <i>Heliconinae</i> .	“ <i>Stalactinae</i> .
“ <i>Danainae</i> .	“ <i>Erycininae</i> .
“ <i>Satyriinae</i> .	Fam. <i>Lycaenidae</i> .
“ <i>Brassolinae</i> .	“ <i>Papilionidae</i> .
“ <i>Nymphalinae</i> .	Subfam. <i>Pierinae</i> .
	“ <i>Papilioninae</i> .
	Fam. <i>Hesperidae</i> .

In 1864 (*Trans. Linn. Soc.*) this scheme was so modified as to bring the first two subfamilies of the Nymphalidae between the Brassolinae and Nymphalinae, doubtless on account of the structure of the caterpillar.

In the following year Trimen issued his *Rhopalocera Africae australis* in which the classification of Doubleday and Westwood was expressly followed; while the Felders published (*Wien. ent. Monatsschr.*) a list of butterflies of the Rio Negro in which these were separated into a dozen families in the following order: Papilionidae, Pieridae, Lycaenidae, Erycinidae, Libytheidae, Danaidae, Acraeidae, Heliconidae, Nymphalidae, Biblidae, Satyridae, Hesperidae; this essay is mentioned because the authors adopted the same order in their great work on the Novara Lepidoptera in 1864-67, excepting that a family Neriidae [*Stalactinae* Bates] was added after Erycinidae, and Eumesiidae after Satyridae.

The ideas promulgated by Bates did not at once take root, for in an advanced text-book of the day we find Gerstaecker (*Carus, Handb. Zool.*, ii: 1863) following mainly the order proposed by Boisduval, but placing the Erycinidae and Lycaenidae under Boisduval's *Suspensi*!

Gruppe I. *Succincta* (Equites, Pieridae).

Gruppe II. *Suspensa* (Danaidae, Heliconidae, Acraeidae, Nymphalidae, Morphidae, Satyridae, Libytheidae, Erycinidae, Lycaenidae).

Gruppe III. *Hesperidae*.

So also in the following year Herrich-Schaeffer, in his *Prodromus*, gives a new classification of butterflies in which several more minor groups are credited with a family rank and no intermediate divisions used; the “families” follow each other in the following sequence: Heliconina, Danaina, Brassolina, Biina, Hetaerina, Satyrina, Elymniina, Ragadina,

Eurytelina, Nymphalina, Libytheina, Erycinina, Lycaenina, Pieridina, Equitina, and Hesperidina. Excepting in the interchange of position of the Pieridina and Equitina, the order is that of Heinemann.

Rambur, in a too little known work on the Lepidoptera of Andalusia (1866), dropping the Boisduvalian system he had employed in 1838 in his incompleated work on the same fauna, divided the butterflies into two tribes, Papilioniens and Hesperiens, as he previously had done into Platyptères and Microptères, and the former into eight families arranged in the following order: Nymphalides, Apaturides, Satyrides, Libytheides, Erycinides, Lycenides, Pierides and Papilionides. Whether he was acquainted or not with the reform Bates had suggested does not appear, but if not, the similarity and independence of his scheme show the hand of a master.

In 1869, in Butler's Catalogue of the Fabrician butterflies, published by the British Museum, we find the first attempt to follow throughout the whole group the leading of Bates, it being adopted with but trifling variations; and ever since the English have been foremost in returning to what was practically the early continental method, from which the French entomologists had so long led the world astray.

In 1871, appeared the well known Catalogue of European butterflies by Staudinger, — a work which has become a necessity to every student of European Lepidoptera, but has also been a great block to the proper appreciation of the relative affinities of the larger groups; the obvious advantages of following an otherwise excellent catalogue prevents the acceptance of views, which, if held, require one to follow in his cabinets and writings a different order from that adopted in the catalogue. In this work, followed in the main by Möschler in his arrangement of European butterflies (*Abhandl. naturf. Ges. Görlitz*, 1879) and by Frey in his Lepidoptera of Switzerland (1880), the butterflies are divided into families with the following order: Papilionidae, Pieridae, Lycacnidae, Erycinidae, Libytheidae, Apaturidae, Nymphalidae, Danaidae, Hesperidae. Worse confusion of proper sequences could scarcely have been found, if it were not that there are undoubted tolerably near affinities between each of these "families" and those on either side of it, excepting between the Danaidae and Hesperidae, which have exceedingly little in common not shared by all butterflies; and the defender of any near relationship would hardly venture to make himself heard. If, with the exception of the Hesperidae, the order were exactly reversed, it would be far nearer the truth.

As an offset to this, and an excellent one, there appeared in the same year a catalogue of the Lepidoptera of the whole world, the *vade mecum* of lepidopterists. In this work Kirby follows in the main Bates's divisions but with a rather more numerous array of subfamilies: —

Nymphalidae ; subfam., Danainae, Satyrinae, Elymniinae, Morphinae, Brassolinae, Acraeinae, Heliconinae, Nymphalinae.

Lemoniidae ; subfam., Libytheinae, Nemeobiinae, Euselasiinae, Lemoniinae.

Lycaenidae.

Papilionidae ; subfam., Pierinae, Papilioninae.

Hesperiidae.

In the same year, too, appeared in England a work on British butterflies by Newman, remarkable more for the origination of new names than anything else, but still indicating that the awakening brought about by Bates was bearing fruit in independent thought. The interest attached to the grouping is that, like the Wiener Verzeichniss, it is founded largely upon characters drawn from the early stages. The butterflies are termed “*Lepidoptera pedunculata*” in view of the development of the eremaster, and are divided first into Detegentes and Celantes ; the latter comprise the family Hesperidae, while the former are subdivided as follows :—

i. *Suspensi*.

a. Spinigeri (Argynnidae, Melitacidae, Vanessidae, Neptidae).

b. Limaciformes (Apaturidae, Satyridae).

ii. *Succincti*.

a. Onisciformes (Erycinidae, Lycaenidae).

b. Cylindracei, seu Vermiformes (Rhodoceridae, Papilionidae, Pieridae).

A curious and indefensible thing about this minor grouping (for which no reasons are given or can be inferred from the context) is placing the swallow-tails between the yellows and the whites ; but as a whole, it has some marked merits.

A somewhat similar attempt, largely based on larval characters, was made by a French naturalist, better known for his work on the lower families of Lepidoptera, Mr. Guenée. In 1875 he prepared a list of the Lepidoptera of the department of Eure-et-Loir in which he proposed the following somewhat complicated classification, in which the atrophy of the legs was recognized, but not given any special value.

Div. <i>Bicalcarati</i> .	Phal. Tetrapi.	Leg. Onisciformes.
Leg. Fusiformes.	Trib. Spinosae.	Phal. Micropi.
Phal. Hexapi.	Fam. Argynnidae.	Trib. Sulcati.
Trib. Tentaculatae.	Fam. Vanessidae.	Fam. Theclidae.
Fam. Papilionidae.	Trib. Carunculatae.	Fam. Lycaenidae.
Trib. Granulosae.	Fam. Nymphalidae.	Phal. Heteropi.
Fam. Pieridae.	Fam. Apaturidae.	Fam. Nemeobidae.
Fam. Rhodoceridae.	Trib. Fureulae.	Div. <i>Quadricalcarati</i> .
	Fam. Satyridae.	Fam. Hesperidae.

In 1872, I published the first expression of my views on the classification of butterflies in a Systematic revision of our New England species, with a few others. Then believing that the law of priority should be extended to all the higher groups as well as to genera and species, and finding a great neglect of the names employed by the founders of the science, I endeavored to introduce these names anew, — an attempt which probably somewhat obscured my main purpose of introducing a more

rational classification of the insects themselves. The present adoption of the sensible rules of nomenclature promulgated by the American Ornithologists' Union no longer requires adherence to this standard. The scheme adopted, which of course did not comprise such groups as were exclusively tropical, was as follows :—

Fam. <i>Nymphales</i> Linn. [Nymphalidae].	Subfam. Ephori Herbst [Lycaeninae].
Subfam. Oreades Borkh. [Satyrinae].	Tribe Armati Hübn. [Theclidi].
“ Tribuni Herbst. [Euploeinae].	“ Adolescentes Hübn. [Lycaenidi].
“ Najades Borkh. [Nymphalinae].	“ Villicantes Hübn. [Chrysophanidi].
Tribe Archontes Herbst [Nymphalidi].	Fam. <i>Papilionides</i> Latr. [Papilionidae].
“ Phalerati Hübn. [Apaturidi].	Subfam. Danai Linn. [Pierinae].
“ Praefecti Herbst [Vanessidi].	Tribe Fugacia Hübn. [Rhodoceridi].
“ Dryades Borkh. [Argynniidi].	“ Voracia Hübn. [Pieridi].
“ Hamadryades Borkh. [Melitaeidi].	“ Frugalia Hübn. [Anthocharidi].
Subfam. Hypati Hübn. [Libytheinae].	Subfam. Equites Linn. [Papilioninae].
Fam. <i>Rurales</i> Fabr. [Lycaenidae].	Fam. <i>Urbicolae</i> Fabr. [Hesperiidae].
Subfam. Vestales Herbst [Lemoniinae].	

As will be seen, this arrangement very closely follows the order of Bates's classification, but differs somewhat in subordinate points. With slight alterations the same classification was followed in my unfinished Synonymic list of American butterflies (Buff. Bull. 1875-76).

Burmeister in his *Lepidoptera of the Argentine Republic* (1878) follows Doubleday, as will be seen by the following order of his families: Papilionidae, Pieridae, Danaidae, Heliconiidae, Nymphalidae, Satyridae, Erycinidae, Lycaenidae, Hesperidae and Castniidae.

Another European naturalist, resident like Burmeister in South America, Constant Bar, published in the same year a critical essay on the classification of butterflies, in which, evidently availing himself only of such historical information as came from French sources, and taking into primary account the suspension of the chrysalis, the attitude of the wings of the butterfly in repose, and the use of the front legs, he divided the “*Rhopalocères*” into five sections and sixteen tribes, of which ten were given to the *Suspendues*. The plan is as follows :—

<i>Suspendues.</i>	<i>Heliconides.</i>	<i>Lycaenides.</i>
Satyrides.	Danaides.	<i>Variables.</i>
Brassolides ou Pavonides.	Mécanitides.	Erycinides.
Morphides.	Leptalides.	<i>Enroulées.</i>
Apaturides.	<i>Succinctes.</i>	Hespérides.
Nymphalides.	Piérides.	<i>Endophytes.</i>
Acraeides.	Papilionides.	Castnides.

Next come in sequence of time three important English works, which follow substantially or completely the classification of Bates: these are Moore's *Lepidoptera of Ceylon*, Marshall and de Nicéville's *Butterflies of India*, and Distant's superb volume on *Rhopalocera Malaya* ; to which we may add the second edition of Trimen's *South African Butterflies*, now publishing.

In a brief paper in the *Bulletin of the Brooklyn Entomological Society*,

(1883), J. B. Smith divides the butterflies into five families (following as he says W. H. Edwards, though Edwards has never defined a single family), Papilionidae, Nymphalidae, Erycinidae, Lycaenidae, and Hesperidae; but a couple of years later (loc. cit. 1885), he changes the order to Nymphalidae, Erycinidae, Lycacnidae, Papilionidae, and Hesperidae.

Claus, in his text book of zoology (Engl. ed., 1885), recognizes six families which, though in no way characterized, are ranged in the following order:—Equitidae, Pieridae, Nymphalidae, Satyridae, Lycaenidae, Hesperidae.

In the same year Girard published the Lepidoptera of his *Traité d'entomologie*, in which, while he recognized but four principal groups, with the same scope and sequence and (except their Gallic form) the same names as will be found in the present work, the Nymphaliens are separated into twelve different and equal divisions; even in these, had not the Agéronides and Libythéides been placed at the head, the sequence would have been substantially that employed in the present work.

In this year also the late Dr. E. Schatz began his work on the structure of butterflies in connection with Staudinger's *Exotische schmetterlinge*. In this work, while recognizing the importance of Bates's contribution to the classification of butterflies, the author fails to adopt its most characteristic features (the limited number of primary groups, and the low position of the Papilionidae), and subdivides butterflies into no less than fourteen families, in the following order: Papilioniden, Pieriden, Danaiden, Neotropiden [Danaoid Heliconidae of Bates], Heliconiden, Acraeiden, Nymphaliden (in which twelve groups are recognized) Morphiden, Brassoliden, Satyriden, Libytheiden, Eryciniden, Lycaeniden and Hesperiden. In this work (unfortunately not completed before the death of the author), an attempt is made to define all the groups above species for the whole world, but it is by no means done in a satisfactory manner.

The last general attempt that has been made to give in a brief shape the general classification of butterflies is that by Plötz in his *System der schmetterlinge* in 1886. In this compact little essay the butterflies are first divided into Papilionidae and Hesperidae, the latter with the single family Hesperina, the former with a still further intermediate grouping (presumably families) into Nymphalidae, Lemoniidae and Succinctae. The first of these contains eight divisions: Heliconina, Danaina, Acraeina, Nymphalina, Morphina, Brassolina, Satyrina and Elymniina; the second, three: Libytheina, Eumesiina and Erycinina; and the third, three others: Lycaenina, Pieridina and Equitina. The principal objection to this scheme is his placing the Lycacnina in the same division with the Pieridina rather than with the Erycinina, and the much greater distinction between the three subfamilies of Succinctae than between most of the other subfamilies.

This review shows that there has been very great diversity of view among naturalists, first regarding the number of primary groups into which butterflies should be divided, and, second, with regard to their sequence. In only a single instance has there been entire unanimity, and that is in the separation of the Hesperidae, as a distinct group of greater or less value, and its low position next the moths; and, with the exception of one or two instances where the authors have been led away by the striking peculiarities of the caterpillar, no one has ventured to place the Lycaenidae at the head. If, as in this work, we consider the butterflies to be primarily divisible into four great families, the contention has generally lain between the superiority of the Nymphalidae and of the Papilionidae. Notwithstanding that the first keen investigator of the structure of butterflies, Réaumur, more than a century and a half ago, showed how widely the structure of the front legs of the Nymphalidae differs from that of those of other butterflies, Linné, the first great systematist, paid not the slightest attention to the value of distinctions, of whose character he must have been aware and which at first he used, but based his initiatory groupings of butterflies largely on mere superficial resemblances drawn from the form and ordinary attitude of the wings; and although in his earliest works he placed the Nymphalidae at the head, when his *Systema naturae* reached its climax, he began his system of butterflies with the Papilionidae. In this he was followed implicitly, as might be expected, by his disciple Fabricius, and the influence of these two old systematists upon even the present generation of naturalists is something surprising. For, as we have shown, Geoffroy, more than a century ago, made use of the characters pointed out by Réaumur, in which the Nymphalidae differ widely from the Papilionidae and Hesperidae, and placed the Nymphalidae in their proper position at the widest remove from the Hesperidae. Not only this, but he was followed by all the naturalists of that day,—Borkhausen, Herbst, Cuvier and, in his earlier works, Latreille—in this elevation of the Nymphalidae to the highest rank; with the sole exception, it should be said, of Denis and Schiffermüller and their follower Schrank, who, relying exclusively on characters drawn from the caterpillars, and noting the distinctive characters of those of the Lycaenidae, placed this latter group the highest. But even these authors, who, as we have said, placed their whole reliance on the early stages, brought the Papilionidae in immediate juxtaposition to the Hesperidae. In England, where the Linnean traditions held sway longest, the Papilionidae were given the highest rank even as late as 1815, in Leach's first work, and these views were reinforced by the influence of the French naturalists even down to Westwood and Doubleday. Our review shows that within the last sixty years the principal supporters of high rank for the Papilionidae were, besides those already stated, Lederer, Gerstaecker, Standinger, Claus and Schatz, not to mention Lucas, Trimen (in his earlier

work), Möschler, Frey, and Burmeister, who simply followed in the lines of some predecessors, nor Wallace who has not discussed the general classification of butterflies and so is not mentioned above; while among those who have placed the Nymphalidae highest have been Hübner, Dalman, Ochsenheimer, Heinemann, Herrich-Schäffer and Plötz among the Germans, Duponchel, Bruant, Rambur, Girard, and Bar among the French, and among the English Bates, Butler, Kirby, Newman, Distant, Trimen (in his later work), Moore and indeed all the recent writers.

Among the authors who have placed the Nymphalidae at the head, by no means all have acknowledged the close relationship of the Papilionidae to the Hesperidae. But on the other hand, this has been recognized by many who did not give the Nymphalidae the highest position. Thus it has been clearly pointed out or indicated by Geoffroy, by Denis and Schiffermüller, Schrank, Latreille and Cuvier, by Swainson and Stephens among the idealists or cyclists, by Bruant, Heinemann, Bates, Herrich-Schäffer, Rambur, Girard, Butler, Kirby, Distant, Trimen, Moore, Newman, Smith and Plötz.

The weight of authority, however, is a matter of least importance. The question is rather one of fact, and while we have no right to expect that any great difference in relative rank will be found between groups of so low a grade as families within a single order, we nevertheless do find two very striking facts, which can leave very little doubt in the mind of any unprejudiced student as to the general sequence in which these groups should follow each other. This is the more clearly the case inasmuch as there is no doubt in the mind of any one that one of these families, the Hesperidae, holds the lowest rank and is the most closely related to the moths. It would seem, therefore, as if in the structural departure of the families, as such, from the Hesperidae, we might find a clue to their relative positions; and this is unquestionably the case. The classification which is presented in this work differs only in minor points from that formerly proposed by me, which in its turn followed closely in the line of the reformation by Bates. Any variation in the arrangement of the subordinate groups from that system will be explained in its proper place. It is only desirable here to discuss very briefly the relative position of those families which by all writers are regarded as higher than the Hesperidae. To do this it will be hardly necessary to go further than to point out two series in the structure and habits of butterflies, to show how marked and distinct is the transition from one group to another,—series which have not only been recognized by different writers, but have been considered important enough to be placed at the foundation of their schemes of classification.

In the first place, let us take those features which were first brought forcibly to view by Dalman and afterwards by Boisduval, the latter of whom nevertheless misapplied them in the strangest manner and for no

obvious reason whatever. It is well known that as a general rule moths undergo their transformations to chrysalis within a cocoon, spun by the caterpillar, or in a cell moulded beneath the surface of the ground. The same is true of the lowest family, Hesperidae, which usually make such a cocoon within a rolled-up leaf or cluster of leaves, and hence had given them by Boisduval the term *Involuti*. It was not noted by him, nor has it been, as far as we are aware, by any author, though figured by many, that within this cocoon they generally, perhaps always, spin a pair of shrouds, into the middle of one of which they plunge their cremaster, while by the other they support the middle of the body (86:26; 87:12).

Now, remove this outer cocoon and leave the shrouds, and one has, with only such changes as are absolutely required by the lack of the encircling cocoon, the character of the support of the chrysalis of the Papilionidae, *viz.*, a button of silk attached to the object from which the chrysalis hangs, and a loose girt around the middle of the body. In the Lycaenidae, we pass simply to a still closer attachment of these fastenings, so that the rounded chrysalis appears almost glued to the surface to which it is attached; and these two families, the Lycaenidae and the Papilionidae were classed by Boisduval under his *Succincti*. In the Nymphalidae, by the loss of the median girt the chrysalis hangs suspended by its hinder end, and forms the group termed by Boisduval *Suspensi* or *Penduli*, which he and his followers interpose between the *Involuti* and the *Succincti*. Yet we have here a regular progression from the cocoon of the moths to the almost total absence of the use of any silk for the quiescent period of life. Even the few exceptions to this rule seem to be entirely explainable as instances of reversion. Thus the only case among the higher butterflies where a cocoon properly speaking is made, is in the subfamilies most closely allied to the Hesperidae, among the group of Parnassidi and Anthocharidi;* and again in exceedingly feeble instances where the necessities appear to be overwhelmingly great, among some of the higher Nymphalidae, which have lost even the last remnant of the cocoon of moths; *viz.*, in some of the Satyridae, which lack cremastral hooks and undergo their transformations ordinarily in the rudest form of a cell which they can construct above or at the surface of the ground, by the mere movements of the body and the spinning of one or two threads of silk. So, too, there are known to be one or two instances where one of the Nymphalidae is suspended so firmly by its cremastral hooks as to hold the chrysalis in a rigid oblique position very akin to that of the Lycaenidae, but without the aid of the median girt; and as a forerunner of the "suspended" condition, one or two of the Lemoniinae, species of *Stalachtis* and *Emesis*, are stated by Bates to have an entirely similar mode of pupation. Again, another of the Nymphalidae, *Ageronia*, is said by Lacordaire to be supported in part by a median girt

*Bar asserts that the same is true in some South American Lemoniinae.

which, if true, might be looked upon as an atavistic relic of its ancestral condition; but Bar, Burmeister and Müller say it hangs like other Nymphalidae. Moreover, an additional feature appears in the structure of the chrysalis of a large number of the Nymphalidae, which would seem to indicate that they inherit the mark of the "succinct" condition of their ancestors, in the straight ventral surface of the entire chrysalis, a feature absolutely without value in its present suspended condition, but full of meaning, since it is one necessarily common to all the close bound members of the higher Succincti, the Lycaenidae.

The second series which one may follow is that which has been seized upon by writers from the earliest times, — the structure of the front legs. In the Hesperidae, the fore legs, like those of the heterocerous families of Lepidoptera, differ in no respect from the others, excepting that the hind tibiae are usually furnished with a pair of spurs at the middle as well as at the tip, and the fore tibiae bear a peculiar epiphysis, the use of which is unknown, but which, morphologically, is unquestionably a spur. In the subfamily Papilioninae, the middle pair of spurs of the hind legs is altogether lost, but the fore-tibial epiphyses remain and the fore leg is otherwise entirely similar in character to the other legs. Next, in the closely allied subfamily, Pierinae, the tibial epiphyses disappear, but the fore legs still remain identically like the other pairs.

As soon, however, as we have reached the Lycaenidae, we notice signs of an approaching abortion of the fore-legs, but only in one sex, the male. In the Lycaeninae, while the fore leg of the female does not differ from the other legs, that of the male begins to lose a part of its armature and to become abbreviated: the tarsal spurs are denuded of scales and both the tibial and tarsal spines are diminished in number; the paronychia and pads are invariably absent; and the claws are represented by an apical spine or spines differing from the other spines at most in size. In the Lemoniinae the change has already become much greater; for, with scarcely an exception, the fore leg of the male has become very much smaller than in the female, and while each part is reduced in size, the tarsus is represented by a diminished number of joints, totally devoid, as is also the tibia, of any armature whatever, but clothed abundantly with long scales and hairs. There is here also sometimes a faint indication of change in the female, the spines of the tarsus being less abundant than on the other legs.

In the Nymphalidae, the change affects both sexes; not, however, in the lowest subfamily, the Libytheinae, which, on this account, many authors who have given special attention to the structure of the legs have classed with the Lemoniinae. But in all other Nymphalidae we have for the first time both sexes represented in the atrophy of the fore legs, and the abortion is also carried to a far greater extent. They are also frequently furnished, especially in the male sex, with a spreading brush of long hairs,

which gives them a peculiar lappet-like appearance. They are quite useless, and in the Satyrinae are reduced to the extremest degree.

When we remember that the small size of the prothorax is one of the most striking and massive features by which the Lepidoptera are distinguished from the lower heterometabolic orders, — the Neuroptera, Orthoptera, Hemiptera and Coleoptera, — any atrophy of *its* parts in the higher members of the order is especially significant. It is an excess, so to speak, of this aristocratic distinction, and such rank as could be expected between the members of a single order might surely be indicated by it. Nevertheless, however important or unimportant this may appear, there is the *series*, which can in no way be disputed, leading from the Hesperidae in a direct and unbroken course through the Papilioninae, Pierinae, Lycaeninae, Lemoniinae to the Nymphalidae, and culminating in the Satyrinae, a series which takes an *identical course* with that of the phenomena of pupation, through Hesperidae, Papilionidae, Lycaenidae and Nymphalidae.

Now what have the supporters of the high rank of the Papilionidae to offer as against such series? No series whatever; no gradation of characters whatever. No one of them claims it. The only characters for which they maintain the supremacy of the Papilionidae are drawn exclusively from one-half the family, the Papilioninae.* These are 1st, the “apparently four-branched median nervule” of the fore wing, 2d, the spur on the anterior tibiae, and 3d, the osmateria of the larva. As to the 1st, it is a character of definition at the most, of a character easily paralleled among other groups of butterflies, having no claim to superiority on any conceivable ground, and a mark indeed, of inferiority, since it is shared by the Hesperidae and by them only, as is also the two-branched subcostal nervure of the hind wing, as Spångberg points out. As to the 2d, it is again a mark of low rank, as it too is shared by many of the Hesperidae, and among butterflies only by them, but is well developed in many moths and especially in the Bombycidae and Phalaenidae. And as to the 3d, so seductively put forward by Wallace, it has more than its match in the abdominal caruncles of the Lycaenidae (not to mention those of many moths) which are double in character, and the more prominent ones more complicated in structure and paired. The osmateria are even said by Boisduval to be exactly repeated in the larva of *Urania*. The features, therefore, by which the naturalist would claim high rank for the Papilionidae are utterly insufficient. They may indicate their low rank, or at the most form special distinctive features with no token of high character about them. When any characters can be shown in the Papilionidae with any mark of superiority about them, or, characters common to all butterflies which lead from the Hesperidae in a regular progression through the other groups to find their culmination in

* It is of no consequence that many hold the Pierinae as a group of family rank; it always has to be associated with the Papilioninae as its very next neighbor.

the Papilionidae, then it will be in place to discuss further the proper serial or other arrangement of butterflies. Until they can, the numerous characters by which the Papilionidae, and the Papilionidae alone, are related to the Hesperidae must be regarded, with the series shown above, to settle the matter beyond reasonable dispute. The facts, as known at present, admit of but one interpretation.

III.

THE PHYSICAL FEATURES AND FAUNISTIC DIVISIONS OF NEW ENGLAND.

THE PHYSICAL GEOGRAPHY OF NEW ENGLAND.

BY W. M. DAVIS.

"Yours for instance, you know physics, something of geology,
Mathematics are your pastime; souls shall rise in their degree;
Butterflies may dread extinction,—you'll not die, it cannot be !
BROWNING.—*A Toccata of Galuppi's.*

New England is a rugged country of mountainous structure, worn down to a moderate relief in its old age, depressed so as to submerge part of its margin beneath the sea, and unevenly veneered over with a broken sheet of drift, which covers many of its smaller hills and buries nearly all the valley-bottoms out of sight. It is built in greatest part of crystalline or of old and much disturbed bedded rocks, that have undoubtedly at some former time given it a much stronger relief than it possesses at present; but it is now so long since its rocks were crowded into upheaval and extrusion that little more than the roots of its old mountains remain. Indeed, its rocks are so old, and even the last period of its overturning so remote, that it has probably been at some time in the past denuded to a surface of gentle undulation; and it is in this surface that the present valleys have been cut after a later time of general elevation. But even this change is ancient, for little of the old surface can now be seen. It may be reconstructed from such remnants as the plateau-like uplands of central or western Massachusetts, where the relatively deep and narrow valleys of Deerfield and Miller's rivers, that enter the Connecticut from the west and east near Greenfield, show that a good volume of high-level country still remains there to be consumed; it may be faintly perceived at a greater altitude in the White Mountains, where the broad surfaces between the dark glens, that are now eating their way back into the mountain masses, manifest little topographic sympathy with the complicated structure of the upturned rocks: but in the greater part of New England, the larger streams

had already in preglacial times sunk their channels well down towards the base-level, the side streams had become very numerous and the valley-slopes had widened out as the intervening hills wasted away; and a rolling, hilly surface, rising in places to mountains of moderate heights, has thus been produced. It is not desired to affirm in this description that the earlier erosion had produced a perfect plain; considerable inequalities doubtless remained at the time of general elevation; nor that all our rivers are new-born; the larger ones may still follow the course of their ancient predecessors; nor that the elevation was sudden, single or uniform; it was more probably progressive and uneven: but it can hardly be questioned that the preparation of our topography required some such process as is here sketched. Pennsylvania has had a similar history; but there the relatively simple and orderly structure of the rocks compels a correspondingly simple and orderly arrangement in the present topography. In New England, the harder and higher parts of the old surface presumably still remain in the mountains and hills of to-day, but the rock structure which determined the arrangement of these parts is so complicated that a simple and systematic classification of the present topography is impossible. Moreover, New England has been heavily glaciated in comparatively recent times, and although ice cannot be held responsible for the production of the greater topographic forms, it has been directly and indirectly most potent in fashioning the details of form which are familiar to us on every side. Before considering these, the larger physical divisions of New England may be briefly described.

There are five divisions easily recognized. The Hudson-Champlain valleys, which mark the natural or physical boundary of New England on the west; the Green Mountains and the associated ranges on their western slope; the great valley of the Connecticut River; the White Mountains, descending to a plateau with occasional mountains in southern New Hampshire, and continued as a dissected plateau in Massachusetts and Connecticut, while to the northeast the disconnected mountains of northern Maine may be placed in the same group; and finally the lower coastal slope from Rhode Island north-eastward.

The Green Mountains may be conveniently taken first. Their main range consists of gneissoid rocks, trending a little east of north through the western parts of Connecticut, Massachusetts and Vermont. South of the latter state, they form a dissected plateau, under 2500 feet in height; farther north, the elevation increases, and the range is dominated by well marked summits, four of which rise over 4000 feet: Jay Peak, 4018; Mansfield Mountain, 4389; Camel's Rump, 4077; and Killington Peak, 4221. It is, curiously enough, only in the northern, higher portion of the range that it is traversed by rivers; the Winooski and the Lamoille, flowing from east to west, open low passes (about 400 and 500 feet) for transverse roads,

while farther south it is generally respected by the streams as a divide. North of our boundary, the range encloses the upper basin of the St. Francis river, but decreases in height and disappears in the lowlands of the St. Lawrence about the Chaudière river.

On the west of the Green Mountains lies the Taconic range, whose disconnected summits consist of folded schists rising from limestone valleys. The range is best developed in western Massachusetts and southwestern Vermont, where the chief elevations are, beginning on the south, Mt. Everett, 2624; Greylock, 3505; Mt. Eolus, 3148; Mt. Equinox, 3872. The associated valleys have their highest level at about a thousand feet in Berkshire, Massachusetts. A second subordinate range lies along the eastern shore of Lake Champlain; it is built of red sand-rock, dipping to the east and presenting bold bluffs to the west; the highest peaks are Buck and Snake mountains, the latter rising to 1310 feet. These two ranges are traversed by many streams.

The Hudson and Champlain valleys trend north with the strike of their bedded rocks, and are doubtless guided also by the great dislocations that pass between the Green Mountains on the east and the Adirondacks and Catskills on the west. The Hudson still maintains an open passage to the sea, holding its way even through the Highlands, where the Green Mountains turn south-westward to New Jersey; but the Champlain valley has been converted into a lake, as will be further noted below, and its side valleys are flooded into bays while its ridges stand up in promontories and islands. Its waters now stand at an elevation of one hundred feet and the divide south of Whitehall between the waters flowing north and south is under two hundred feet above the sea. To the north, the Champlain valley expands into the great plain of the St. Lawrence.

The Connecticut valley is a strong depression between the mountains. At the junction of the Passumpsic with the main stream the elevation is a little less than 500 feet. Thence southward, the river course is remarkably straight, following close to a line of ancient slates, between New Hampshire and Vermont, and then along the middle of the Triassic sandstones to central Connecticut at Middletown, where the river turns southeast through the crystalline highlands, while the valley goes on to Long Island Sound at New Haven. This oblique outlet is shown to be old by its gently sloping sides; it serves better than any other single feature to demonstrate that the larger lines of our present drainage were determined before the land stood at its present attitude and altitude.

The valley is diversified by mountains of three kinds. In Vermont there are several isolated masses of intrusive granite that rise from the lower ground, of which the conical Ascutney (3163 feet) may be taken as the finest example. In Massachusetts and Connecticut, there are ridges of trap and sandstone. The latter seldom attain prominence south of Mt. Toby

(1275 feet) and Sugar Loaf (709) in Massachusetts above Amherst; the former constitute a characteristic feature of the valley farther south. The trap occurs chiefly in interbedded sheets, dipping to the east, with bold convex outline to the west, broken by oblique fault-valleys: the highest points on the ridges are Mt. Holyoke (954) and Mt. Tom (1150) near Northampton, Mass., and West Peak (996) and Higby Mountain near Meriden, Conn. The district of the Hanging Hills, between Meriden and Farmington, is among the most picturesque in southern New England. Mt. Carmel, a little farther south, is a dike standing up in a bold ridge.

The White Mountains of New Hampshire include several subordinate groups separated by deep valleys. The chief of these is the Presidential range, culminating in Mt. Washington at an altitude of 6293 feet, with Mounts Monroe, Clay, Jefferson, Adams and Madison, all over five thousand feet: this group stands pre-eminent among its neighbors, as the White Mountains exceed the other mountains of New England. To the east, the Carter range rises to 4856 feet, beyond which the mountains are scattered and of less elevation, soon falling off to the lowlands of Maine. To the north, there is the Starr King group (3925) and beyond this the Pilot range. To the west is the Franconia range, containing Twin Mountain (4922), Mt. Lafayette (5269), Mt. Lincoln (5098) and Haystack (Garfield, 4520); and isolated beyond these is Moosilauke (4810) on the eastern border of the Connecticut valley. Southward from the Franconia range lie several groups, including Mt. Carrigain (4701), Tripyramid (4189) and Passaconaway (4116).

There is little continuity or uniformity of arrangement in this complicated mountain region. The rocks are crystalline or highly metamorphosed, and are greatly disturbed and eroded: their massive structure and the heavy glaciation that most of them have suffered prevent the development of much topographic detail, and most of the summits are blunt shoulders with rounded spurs; but at times the gneissoid and schistose rocks give expression to ridges and cliffs, as about Mt. Washington, where the slopes of loose weathered boulders descend with the dip of the beds, while the outcrop face is marked by precipitous walls of solid rock. Chocorua (3508) on the southern border of the range is one of the sharpest peaks.

The timber line lies, on Mount Washington, between 4000 and 4500 feet above the sea: at greater heights there is a well marked alpine flora. The open lower valleys are generally cleared, but the intermediate slopes are heavily forested, except where too rocky and precipitous for tree growth, or where bared by recent fires, or by slides, such as those of Tripyramid in 1869 and 1885; clearings have not yet desolated the mountains, and from many summits, such as Mt. Carrigain, little more than a rugged tree-covered wilderness is to be seen.

Unlike the Green Mountains, the present range is nowhere traversed

from side to side by streams. There is continuous divide from Mt. Carr, south of Moosilauke, over the Franconia and Presidential ranges to the Carter group, and again southward from the Franconia range to the Tripyramid groups, and northward from Mt. Washington to Starr King and beyond. But on the other hand, the range is throughout its length characterized by deep transverse notches, dividing it into the groups above named; and as the deepest notches have a north and south trend, with flat summit passes and rather smooth slopes, a considerable but undetermined share of their depth may be attributed to glacial action, of which more below. The finest of these notches are: Dixville notch, east of Colebrook, with a summit height of 1831 feet, separating the waters of the Connecticut and Androscoggin; the Pinkham notch, on the eastern side of the Presidential range, with a divide at a height of 2018 feet between streams leading to the Androscoggin and the Saco; the White Mountain or Crawford notch, west of the same range, reaching 1914 feet at the divide between the headwaters of the Saco and the Ammonoosuc; the Franconia notch, where the Pemigewasset flows southward and forms the Merrimack, from a divide at a height of 2014 feet, which descends northward to the Ammonoosuc; and Kinsman's or Woodstock notch between the Franconia Mountains and Moosilauke, dividing branches of the same streams at a height of about 1650 feet.

The mountains are further dissected by deep, steep-walled ravines and gulfs, where the most active consumption of the mass is now going on: Tuckerman's and King's ravines and the Great Gulf, all in the Presidential range, are among the most picturesque of these.

Southward from the White Mountains, a plateau-like highland extends, with an elevation of about a thousand feet, between the Connecticut and Merrimack rivers, into Massachusetts, and then rapidly declines in northern Connecticut. Several isolated mountains rise upon it, the finest being Kearsarge (2942), Monadnock (3169) and Wachusett (2018). The highland is generally well drained; no lakes of large size occur upon it, although small lakes or ponds and flat meadows are common. Northeastward from the White Mountains, an unsettled forest country of scattered mountains and large lakes extends through northern Maine. Its elevation is about fifteen hundred feet around the head waters of the Androscoggin, falling off to 1023 feet at Moosehead lake, and about 500 at Madawaska. The height of the mountains in the region are as yet poorly determined, as nearly all explorers here follow the water-ways alone, avoiding the surrounding forests and swamps. Katahdin, the highest summit, reaches about 5215 feet.

The lower lands that fringe the coast are generally less than five hundred and often under two hundred feet above sea-level. They include the southern third of Connecticut, all of Rhode Island, southeastern Massa-

chusetts and the eastern third of the rest of the State, New Hampshire from Lake Winnipiseogee to the coast, and fully a third of Maine. This region is by no means as level as the coastal plain of New Jersey and the Atlantic border farther south, but is irregularly broken by rocky hills among flat, drift lowlands. Some of the elevations might rank with small mountains, as the Blue Hills (635), a little south of Boston, and in Maine, Agamenticus (673) back of York, and Green Mountain (1527) on Mt. Desert. On the other hand, large areas are wanting in rocky hills, as in southeastern New Hampshire, and all of Massachusetts below Plymouth. Cape Cod and the islands to the south and west are essentially the product of glacial action, which is next to be considered.

It was over a country whose larger divisions have now been described that the quaternary ice-sheets crept down from the north. The ice scoured out the valleys, smoothing off the spurs and ridges on their sides. Crawford's Notch in the White Mountains, through which a heavy stream of ice must have flowed, is probably as good an example as we possess of a valley form thus simplified. The glacial sheet rose and covered all the hills and wore down their peaks and pinnacles: Mt. Monadnock, whose structure is well adapted to develop a ragged crest-line, has lost many of the sharp edges that it must once have had, and over its rounded summits, the marks of ice-dragged stones are plainly visible. The total effect of the glacial invasion was most likely towards diminishing the topographic relief of New England, not only by rubbing down the hills and ridges, but even more by leaving the drift-rubbish chiefly on the lower ground, greatly to the embarrassment of the streams that took possession of the country again as the ice melted away.

The ground moraine, the immediate product of the moving ice-sheet on the ground beneath it, known by the Scotch name, till, is generally absent from the higher, steeper hills, but is spread with smoothly rolling surface, somewhat fluted in the direction of ice-motion, over the lowlands and flat uplands. The contrast between the upper zone of glacial erosion and the lower zone of drift accumulation is admirably shown in the smaller side valleys among the Berkshire hills of Western Massachusetts. In central and southern New England, the till often takes the form of oval, rounded hills of evenly arched profile, now known by the Irish name, drumlins; the largest of these are over half a mile in length and rise more than two hundred feet above their base: they are seen about Boston, where they make the harbor islands, and again on the uplands about Brookfield, Mass., and west of Putnam, Conn., where they control the shape of the country. Heaps of drift, forming hills and enclosing hollows of marked topographic value, known by the Swiss name, moraines, mark the position held by the edge of the ice-sheet during a time of balanced supply and waste: great terminal moraines may be traced over Cape Cod and the islands to the south

and west as far as the narrows of New York Bay, which they define : sloping plains of sand stretch southward from the morainic hills to the sea ; smaller valley moraines, formed by local glaciers, have been discerned in the White Mountain region towards Littleton and elsewhere. Mounds and ridges of gravel and sand, now commonly called by the Scotch name, kames, lie in the valleys and lowlands, remaining as conspicuous monument of the combined action of ice and water in the closing stages of the glacial period : these are wonderfully developed in Maine, where, under the name of "horsebacks," their height may exceed a hundred feet, and their length is to be measured in miles, with hardly an interruption.

The kames are often associated with sand-plains, probably deposited in lakes temporarily held within the irregular front of the ice during its stagnant melting away, and now sometimes standing up like little plateaus, higher than the valley ground about them ; such as the sand-plain in which Walden Pond is contained near Concord, Mass. Sand-plains and deltas also mark the shores of extinct lakes, marginal to the melting ice, where the land inclined towards its retreating front : such occur in large size in the lateral valleys on the eastern slope of the Connecticut valley in northern Massachusetts and southwestern New Hampshire. The outlet of lakes of this character was commonly over some low pass among the hills, and the line of discharge is marked by abundant sands and gravels, as along the now flat-bottomed Greenwich valley, which led Miller's River from Orange towards Palmer, when its flow direct to the Connecticut was obstructed. The Florence plain, near Northampton, is a sandy delta, built in a lake from which the clay beds of the middle Connecticut valley were deposited after the ice had melted away. In Maine, the plains about Deblois, west of Machias, cover an area of several square miles. Sand-dunes are occasionally formed on these plains, as well as on the more sandy river terraces, and on the sea-coast.

More or less directly connected with the retreating ice are the great deposits of clay, sand and gravel with which many valleys were clogged when their streams were overloaded with detritus washed from beneath the glacial sheet and from the country just uncovered by its melting, and when the general southward gradient of the streams was diminished by the northern depression of the land that accompanied the closing stages of the glacial period. It is in good part by detritus of this kind that the valley-bottoms are so generally buried.

The depression of New England here referred to, and the subsequent oscillations of level have been important in determining the character of its shore line. The beginning and the amount of the depression cannot be accurately stated ; but it occurred after the period of general valley-making, it was associated with the glacial period, it was greater in the north than in the south, and it has left a considerable area that structurally belongs to

New England beneath the waters of the ocean. In geologically recent times there has been a slight recovery from the depression, enough to lift certain postglacial, marine deposits, that smooth over and simplify the littoral topography, two hundred or more feet above the sea in Maine, and less along the southern coast; but not nearly enough to reveal all the previously submerged area. A slight submergence of even later date is also inferred. The present shore-line is therefore of complex origin. The great bays and fiords of Maine, Massachusetts and Rhode Island and the fiord-like channel of the lower Hudson River may be considered as old, submerged valleys and lowlands, eroded chiefly by the ordinary subaerial forces during the former greater elevation of the land, and finished off by glacial rubbing to an unknown amount: the simpler shore-line of New Hampshire and southern Maine, of southern Massachusetts and Connecticut, results from a plentiful supply of drift, with which the depressed and buried lowlands and valleys have there been smoothed over; many of the smaller indentations on these parts of the coast have been enclosed by bars of sand, brought by the waves chiefly from drift-bluffs near by; the shallow waters behind the bars have commonly been filled up to high-tide level as salt-marshes. The cliffs and bars that mark the present shore-line are much more distinct than any that remain at a higher level.

On a surface thus slowly prepared by many processes, standing in an attitude thus lately gained after many oscillations, the present rivers and streams have, as it were, just begun their new, postglacial tasks. The little headwater streams of the mountainous districts still for the most part follow their steep, preglacial ravines. The larger rivers, like the Connecticut, and those smaller ones that are hedged in by steep-sided valleys, like the upper Androscoggin or the Westfield, follow closely along their old courses, although somewhat disturbed by the drift-filling in which they have now sunk their channels; and what with northern elevation whereby the river-slopes are steepened and the base-level lowered, and what with the present slower washing away of the plant-covered drift-surface, whereby the ratio of load to water-volume is decreased, the rivers have been empowered to carry away the detritus that they had shortly before deposited; and thus are formed the terraces that make so characteristic an element of our valleys. The terracing process probably advanced rapidly as long as the rivers found only clay and sand to cut away, for even in the brief postglacial period since the work began, that share of it is very generally accomplished. Further terracing will be accomplished much more slowly, for the deepening of the channels is now retarded by rocky ridges and spurs which nearly all the streams have discovered in opening their buried valleys; it would have required more foresight to avoid these obstructions and settle down precisely on the lowest line of the old valley than can be expected of rivers. When a rocky ledge is thus

encountered, it effectively checks the deepening of the channel in the loose detritus farther up stream, but below it, the soft valley-filling is quickly cut away as low as the next down-stream ledge will allow; at the end of every level stretch thus formed, there is a sudden descent over a barrier to another level stretch below, and thus are produced the alternate flood-plain meadows and low rocky rapids that characterize our rivers. Sometimes a river, wandering too far from its old line, unwittingly sinks its channel on a spur high up on the buried valley-slopes; then a cascade of strong fall is formed, of vast importance to New England in furnishing available water-power, as at Manchester on the Merrimaek, and many other similar points. If the valley be clogged with till, the stream will cut a gradual descent through it, rushing down impetuously among the boulders that remain in its bed: thus the Contoocook flows below Hillsboro' Bridge, N. H., and even the Connecticut has stretches of rocky and stony channel through the Fifteen-mile Falls above Newbury. When rock in place is disclosed beneath or near the till, pot-holes are often worn in it by the boulders, as at the upper falls of the Ammonoosue, above Fabyan's, or at Shelburne Falls on the Deerfield.

Streams of intermediate size, on the more open, lower country southeast of the mountains, have their courses so greatly influenced by glacial deposits that they cannot be regarded as the successors of any corresponding pre-glacial streams; they flow irregularly among the rocky hills, drumlins, kames and sand-plains that were disclosed for their settlement as the ice wasted away, here meandering about a flat meadow that conceals some old channel, there crossing over an old rocky spur or divide, or cutting down a stony dam of boulder-clay, but nowhere presenting that evident relation between stream-volume and valley-size that prevails so manifestly in regions of a simpler history, like West Virginia. Except the terracing in the meadows and the slight gorge-cutting on the old divides and spurs, the surface drained by these new streams has not been developed under their guidance; it was presented to them ready made, and they are just making their first mark upon it. Oliverian Brook is a small example of a stream thus thrown over an old divide: it descends southward from Moosilauke, as if to join a branch of the Pemigewasset, but abruptly turns northward across an ancient pass, cutting a little gorge in the rock, where every traveller in the Montreal railway may see it, and then flowing through meadows to the Connecticut by Haverhill. The gorges of this class are shallower than their relatives in New York because the rocks here are harder. The "flumes" of the White Mountains are not gorges of this origin, but are cut out on vertical dikes that are weaker than the enclosing country rock.

The Saco may serve as a larger type of a new river, except in its upper course where it follows a deep old valley out of the mountains to Conway;

below this point, it wanders about over the Ossipee region and the adjacent parts of Maine, upon broad sand-plains by which the old surface of the country is completely concealed; it seldom touches rock until it crosses a broad ledge over which it falls in picturesque cascades near Hiram, Me., about twenty miles above its mouth. As it happens that the river settled upon this ridge at a high level, the terracing of all the sand-plains further up stream is delayed by the slow cutting of the rock barrier; hence the beautiful intervalle at North Conway, lying smooth between the steep, rocky slopes that enclose it. The Ammonoosuc, on the other side of the mountains, must also once have flowed over an open plain, like that still followed by the Saco in its middle course; but the northern river did not happen to encounter a rocky reef until it had cut deep into the plain and carved it into wide open terraces, as at Littleton. These contracted examples may be taken as the extremes of a series, whose many intermediate members are represented by other rivers in New England.

The general conditions of terrace-making, as stated above, included an increase of river slope, as a result of the greater value of postglacial elevation in the north than in the south. This applies to most of the New England rivers, but manifestly not to northward flowing streams, like the Concord and Nashua rivers: here the effect of unequal elevation must have been to decrease the rate of descent, and it has been suggested that the flat, marshy, untterraced character of their valleys is in good part owing to their weakened flow, thus determined.

One of the most constant results of recent glaciation is the occurrence of lakes, and New England affords good illustration of this rule; for there is small probability that any of the lakes, now so plentifully distributed over its surface, existed before the last glacial period. Some of the lacustrine basins may be due wholly or in part to glacial erosion, but by far the greater number result from obstruction to drainage by the irregular deposition of drift, and thus further characterize the immaturity of drainage already indicated by the rocky rapids and diluvial terraces of the rivers. Some little advance from this immaturity has already been made: the lakes held by drift barriers in the steeper valleys have generally been drained by cutting down at the outlet, and thus the rarity of lakes in the White and Green Mountains and in the plateau valleys is best explained; lakes have lately existed there, as many of the flat meadows attest, but their life was short by reason of the strong slope of their outlets over their weak barriers. The largest and most numerous lakes occur in the lower country from eastern Massachusetts to northeastern Maine, where the plentiful drift is most effective in barring off the old valleys, and where the gentle slope of the streams allows the longest life to the lakes; but here also the water surface has in many cases been somewhat lowered, revealing the former shores as sandy terraces and benches above the present margin.

At present, this process is in the same stage of slow advance that has been described for river terraces, for the outlets have now cut down their channels to a rocky barrier or close to the local base-level, and in either case further deepening of the channel is very deliberate. In their present stage, the larger lakes still retain the ragged shore-line characteristic of an overflow upon an uneven country: all the large lakes, from Winnepiseogee past Moosetocmaguntic to Pomgocquomoc, and to Memphramagog on the other side of the mountains, are as irregular in outline as in name. The lateral outlet of Winnepiseogee and the great volume of drift over the country to the southeast, give strong suggestion that its basin is caused by the obstruction of old valleys. Champlain doubtless belongs to the same class of lakes: for though some of its depth is likely due to glacial excavation, its present outline is essentially determined by the height to which the preglacial valley is flooded back in consequence of drift-barriers in the former lines of drainage: its present outlet is a new stream.

The smaller lakes are generally oval or elongated in the direction of the valley whose obstruction has determined them, as Quinsigamond, east of Worcester, and many others in Maine. The terminal moraines on Cape Cod and on the southern islands contain many small ponds in their depressions, and the southern sides of Cape Cod, Martha's Vineyard and Nantucket possess curious elongated or branching lakes, apparently occupying submerged valleys, enclosed by sand-bars from the sea. Numerous swamps, with characteristic flora, mark the sites of small or shallow lakes recently extinct in all parts of New England.

In a geographical sense, New England is on the whole a well defined province, clearly separated from its neighbors. It has some continuity into the British provinces on the northeast by a prolongation of the highlands and lowlands of Maine beyond our border, and some extension to the southwest by a persistence of the Green Mountain system into the highlands of southern New York and northern New Jersey; this being simply an expression of the prevailing trend of structural and topographic features in the Appalachian system. To the north, there are the wide, low plain and the estuary of the St. Lawrence, cutting us off from the Canadian highlands, a rocky and forest-covered wilderness, with disordered rivers and many lakes, much like northern Maine. To the west, there is the deep Hudson-Champlain valley, a line of long maintained geological depression and disturbance, beyond which lie the rugged Adirondacks, the broad Mohawk valley, and the Catskill plateau: the Adirondacks, unlike our New England mountains in the presence of numerous lakes even to their center: the Mohawk valley, eroded at right angles to all the larger New England river courses: the Catskill plateau, with its benched front and deep cut cloves, the beginning of the great plateau that carries the coal beds of Pennsylvania, Virginia and Kentucky. On the south there

are the drift-veneered islands, without a parallel on the Atlantic coast; and on the east, the beginning of a system of rocky fiords, unknown south of New York, but recurring in greater strength far north in Labrador.

Thus isolated and distinguished from its neighbors, New England offers an interesting and a difficult field of study to the geographer. While the relations of its several parts have been briefly outlined in this chapter, the observer on the ground will find that much more remains to be done than has yet been accomplished in the way of minute and systematic recognition of scenic features. The elements of the present heterogeneous topography, dependent on obscure complications of rock structure and discordant sequence of geological process, will long remain subjects for further investigation.

THE CLIMATE OF NEW ENGLAND. BY W. M. DAVIS.

Etudiez aussi les moments de l'année :
L'année a son aurore, ainsi que la journée.
Ah ! malheureux qui perd un spectacle si beau !
Le jeune papillon, échappé du tombeau,
Qui sur les fruits naissants, qui sur les fleurs nouvelles,
S'envole frais, brillant, épanoui comme elles,
Jouit moins, au sortir de sa triste prison,
Que le sage, au retour de la jeune saison,
Lorsque sur les coteaux, sur les monts, dans les plaines,
Tout est gazon, zéphyr, ou ruisseaux ou fontaines.

DELILLE.—*L'Homme des Champs.*

The climate of New England is as rugged as its surface. Its position on the eastern, leeward side of North America gives it the great variations characteristic of a continental climate rather than the equable conditions of a maritime province. It lies midway in a region having an exceptionally rapid northward decrease of temperature, from the warm Southern States to the cold plains beyond the Great Lakes, and from the mild waters of the Gulf Stream to the ice-bearing current of Labrador; and every change of wind therefore brings it a change of weather. It lies close to a point of convergence of numerous storm-tracks, along which, especially in winter, cyclonic storms pass eastward more frequently and more rapidly than anywhere else in the world; and changes of weather are therefore common, sudden and violent.

The seasons are strongly contrasted. The winter is long and severe, from its violent changes as well as from its low mean and extreme temperature: in the northern interior, snow commonly falls in November and remains till April and its midwinter depth may exceed two or three feet. The spring is short, with a rapid rise of temperature in April and May. The summer is warm and its weather is much more equable than in winter: warm days are recorded well into September and spells of mild weather characterize October.

In summer time, the prevailing southwest winds bring warm air from the southern States, and when re-enforced on cyclonic gradients (that is, by differences of pressure directed to the centre of a low-pressure area) as is not infrequently the case, they cause an oppressive heat: at such times, as well as on cloudless, anticyclonic—or high-pressure—days in June, July and August, maximum temperatures of 90° or 95° F. are reached in the inland valleys, except well to the north; but at the same time, the diurnal range of temperature is strong, especially under anticyclones, averaging twenty or thirty degrees, and often exceeding forty degrees, in the valleys of the hilly or mountainous districts; and the nights are fairly cool. Immediately on the coast, the sea-breeze of day-time moderates the heat and decreases the diurnal range. Cool, fair weather with northwesterly winds, or cloudy, rainy weather with southeasterly winds interrupt the warmth of summer: thunder-storms with occasional destructive squalls and hail-falls occur chiefly while cyclonic storm-centers are passing down the valley of the St. Lawrence. Several tornadoes have been recorded in the Connecticut Valley and elsewhere, but they are rare.

In winter, the prevailing winds are west or northwest, from the cold interior of the country, but these are frequently reversed by cyclonic storms that draw in the damp air from the Atlantic; for few of these storms cross the United States without giving New England some mark of their passage. As they move across Lower Canada, their cloudy southerly wind brings rain and snow; sometimes it is unseasonably warm, rising to a temperature of 50° or 60° even at midnight in midwinter; under such conditions, abnormally high, foehn-like temperatures have recently been noted in the White Mountain valleys. When the storm-center passes south of New England, a chilling snow-bearing wind blows in from the northeast. Closely following the Atlantic winds, come the cold, dry west or northwest winds on the rear of the storm. When the pressure is high in the far northwest, these are intensified into the violent cold wave, under which the temperature may fall thirty or forty degrees in twenty-four hours, in excess of the diurnal range; indeed, in winter when the regular diurnal range is small, it is almost supplanted by the irregular cyclonic change of temperature, then at its highest value. During a cold wave the temperature falls to 0° or -20° , without distinct local variations; but on the clear anticyclonic nights that follow, the minima in the valleys fall to -20° or even -40° , and local variation from valleys to hills is excessive. On Mt. Washington, the cold wave carries the temperature down to -40° or -50° , with the wind blowing sixty or more miles an hour, but during anticyclones, the mountain top may be ten or twenty degrees warmer than the neighboring valley bottoms.

The mean annual and the mean winter temperatures are shown by isothermal lines on the accompanying map. These lines are drawn according

to the data given in Schott's Smithsonian Tables, and in the latest Annual Report of the Chief Signal Officer, supplemented in a few cases by observations reported to the New England Metereological Society; but they can be regarded only as approximations, especially in the north, for they depend in most cases on series of observations of insufficient duration and of different lengths and dates. The temperatures indicated are actual means, no reduction to sea-level having been applied. There are no records for northern Maine. The mean annual for the rest of New England may be concisely described as ranging from 40° in the north to 50° on the southern coast: the winter mean varies from 15° in the north to 30° in the south: the summer mean varies from 60° to 70° . On Mount Washington, the annual, winter and summer means are 26° , 7° and 46° .

The annual precipitation at low-level stations, as given in the sources above named, varies from thirty-five inches in the northwest, to fifty inches in the south and along the coast, except in southwestern Maine, where it is somewhat less; but these numbers give an inadequate measure for all New England, as Mount Washington has an annual precipitation of eighty-five inches for thirteen years record; from which it may be inferred that much of the White and Green Mountain areas have totals at least above sixty inches. The distribution of the precipitation through the year is fairly equable, with a slight maximum in late summer and a minimum in early winter, these variations being rather more marked in the west than near the coast; the irregular variations from year to year are rather strong. The winter snow is heavy in the northern interior, where sleighing is hardly interrupted for three months; in the south and near the coast, occasional mild rains in midwinter may melt the snow to the ground. Frost is occasionally reported even during the summer season in the north. Hail is not common or severe enough to be considered as a climatic factor.

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THE ZOOLOGICAL DIVISIONS OF NEW ENGLAND.

There's nothing situate under heaven's eye
But hath his bound, in earth, in sea, in sky:
The beasts, the fishes and the winged fowls
Are their males' subjects and at their controls.

SHAKESPEARE.—*Comedy of Errors*

Probably no state in the Union presents so striking a variety in its animal life as New Hampshire. Its northern and southern portions belong to distinct continental faunas; above the forest growth of its colder region rise some of the highest elevations east of the Rocky Mountains, and these bleak altitudes support a vegetation and an assemblage of animals intimately resembling those of Labrador and Greenland, while less than two hundred miles distant flourish animals characteristic of subtropical climes.

What is true of New Hampshire is true to an even greater extent of New England; for in the northern hemisphere, rivers flowing south always exert an influence upon the character of the inhabitants upon its banks, and the Connecticut and Hudson, although navigable but short distances, form no exception to the rule. At their southern extremities they reach a warm coast and a latitude where numerous insects occur, whose true metropolis is found in the Carolinas and Florida. Many of these, following the course of the rivers, with their warm, moist banks, penetrate into the heart of the country; some are found in central Massachusetts, a few in southern Vermont and New Hampshire, and one or two are found even in the latitude of the White Mountains. So, too, in addition to the meagre fauna found on the high mountain tops of New Hampshire—limited as far as the butterflies are concerned to two species.—the northeastward extension of Maine toward the Gulf of St. Lawrence doubtless brings within the limits of New England not a few forms characteristic of sub-arctic climes.

The attempt to divide any part of North America into distinct zoological areas was first made by Professor Louis Agassiz in 1854, who sketched, in Nott and Gliddon's *Types of Mankind*, a rude map and briefly characterized the peculiarities of the principal zoological divisions of the whole world. He introduced the terms Canadian, Alleghanian and Louisianian faunas, for the three distinct congeries of animals found in the northern, middle and southern portions of our Atlantic coast. Five years later Dr.

J. L. LeConte published in the Smithsonian Contributions a colored map of the entomological provinces of North America, in which the eastern district so-called was divided into "1, a northern province, including Maine, eastern Canada, Nova Scotia, Newfoundland, etc., and extending westwardly from Lake Superior to Lake Winnipeg and western Canada, which fades insensibly into the great Arctic district; 2, a middle province, limited westwardly by the Appalachian chain, and extending to southern Virginia; 3, a western province, including Minnesota and the states of the valley of the Mississippi, as far as the state of that name; 4, a southern province, including the states south of Virginia and Kentucky; 5, a subtropical province, including the point of the peninsula of Florida; 6, a subtropical province, including the sea coast of Texas."

But the principal work that has been done upon the distinction of faunas in the eastern United States has been by the labors of the ornithologists. In 1863, Professor A. E. Verrill pointed out that the dividing line of the Canadian and Alleghanian faunas cut New England in two, and three years later he defined the limits more exactly as "coincident with a line which shall indicate a mean temperature of 50° F., during the months of April, May and June"; a coincidence which leads him to believe that the distribution of birds is "chiefly influenced, so far as latitude is concerned, by the temperature of the breeding season." Whether, he adds, "a similar law controls the distribution of mammalia, reptiles, insects, etc., can only be determined by further investigation." In describing the course of this isothermal line which marked the northern boundary of the Alleghanian fauna he says: "It passes south of Moosehead and Umbagog Lakes, but rises somewhat northward along the Androscoggin valley, thence it passes southward of the White Mountains through the vicinity of Conway, N. H. It bends northward again up the Connecticut valley as far as Shaftsbury, Vt., where the mean temperature is 50° 91'."

This was followed up by the more formal attempt of Mr. J. A. Allen, who followed exactly in the line of Professor Verrill's suggestion that the distribution of the birds in their breeding season should guide the zoological geographer in his conclusions, and adopted also the indications of the isothermal lines as the basis of his divisions. The line of the division between the Alleghanian and Canadian faunas was described in the following terms: "It . . . is an extremely irregular line, with abrupt and deep sinuosities. Beginning on the coast to the eastward of the Penobscot Bay, it sweeps first somewhat to the northeast, nearly or quite reaching Bangor; thence passing westward and southward, it follows the northern boundary of the lowlands through southern Maine and southern New Hampshire. In the Connecticut valley it rises farther to the northward, and in its southern descent skirts the eastern base of the Green Mountains, passing to the southward and westward of these highlands in Connecticut, and

thence abruptly to the northward. Skirting the eastern border of the Champlain valley, it continues still northward to the valley of the St. Lawrence as far as Quebec; thence turning again southwestward, it passes along the northern border of the lowlands east of the Laurentian hills (including the valley of the Ottawa), and crosses the southern peninsula of Michigan near the forty-fifth parallel." (Bull. Mus. comp. zool., ii: 395.)

In 1883 Dr. A. S. Packard published two editions of a zoo-geographical map of North America, in which the great body of eastern North America was separated into two divisions, a boreal or Canadian province, and an Atlantic or eastern province. The dividing line between these two, with the exception of a belt of the Atlantic province skirting both sides of the Bay of Fundy, ran from the vicinity of the mouth of the Penobscot north-eastward into the edge of New Brunswick, quickly turned upon itself to follow a reversed course until it skirted the southern borders of the White Mountains, when it again turned north-eastward toward the Gulf of St. Lawrence, striking it near the latitude of 70° W.; then it turned abruptly westward toward Lake Superior, following in all this course, as stated by the author, the isotherm of 40° F. Outlying islands of the Canadian province were indicated as found within the Atlantic province in the Adirondacks region and on the summits of the Alleghanies.

Insects, it should be observed, are not regularly migratory animals; and since several generations frequently succeed each other during a single season and winter is passed in very various conditions of existence, we can hardly expect their distribution to follow exactly that of birds. Various causes may modify unequally the distribution of insects belonging to a certain group; too intense cold in our arctic winters; the lack of snow during a less severe season; too excessive heat or too long a drouth in midsummer; or, too sudden changes of temperature at critical periods. To come to our butterflies, they may be found at all seasons of the year, even in mid-winter, of one species or another, in every stage of existence, from the egg, through all the larval stages and the chrysalis, to the imago. The distribution of butterflies is therefore much more complicated than that of birds, whose early stages are always passed in comparatively warm weather, under the guardianship of the mother; and, if more than one brood appears during a season, the second is only the produce of the same pair that raised the first.

It is nevertheless true that the distribution of insects over continental areas coincides in a remarkable way with that of birds; and the general consensus of opinion, drawn not only from the study of birds but from that of other animals as well, as shown by the views of the naturalists already alluded to, and their agreement with the results of our own study

of butterflies, should be carefully noted. In general the line of separation of the Canadian and Alleghanian faunas is placed further south by Allen than by Verrill and Packard. The accompanying map of faunal areas will show that according to my view it should be carried even still a little further south, and if the line in passing through our district presents greater irregularities than in the case of the others, it is due solely to the influence of the Connecticut and Hudson Rivers in carrying northward along their bottom lands many butterflies of the Alleghanian fauna. The line, as I would trace it, starts from the gulf of Maine near the mouth of the Kennebec and runs at first parallel to the coast so as to include Sebago pond, but recedes slightly from the shore near the forty-third parallel, until it strikes the northern border of Massachusetts south of Monadnock, curving around which it turns sharply to the north, crossing the Connecticut River near Ascutney Mountain, turning again southward and following the course of this stream until near the middle of Massachusetts, when it begins to curve westward until it has swung around the higher elevations of the Berkshire Hills in southern Massachusetts, again passes to the northward along the valley of the Hudson, and turns once more to the westward just before reaching Lake George.

But the line as we have here traced it, should by no means be regarded as a fixed one. It is rather the centre of a broad belt whose southern margin limits many of the Alleghanian species, while other species find their northernmost extension at various points within the broad belt; its northern borders mark the ordinary southern limits of the species of the Canadian fauna, which may, however, extend to this middle line or even beyond. The northern limit of the belt would correspond very closely with the dividing line of the Canadian and Alleghanian faunas as marked by Verrill. As will be seen, it starts from the bay of Maine in the immediate vicinity of Mt. Desert, passes to the northward with an easterly inclination up the valley of the Penobscot nearly to the New Brunswick border, then turns to run south-westward parallel to the coast along the margin of the more broken hilly parts of the state, in a line approximately south-west from Mattawamkeag, Me., to North Conway, N. H., interrupted, however, as it crosses the Androscoggin, by a deep bay reaching the New Hampshire border; skirting the White Mountains at their southern limits, it passes barely north of the lake region of New Hampshire, then turns northward again on approaching the valley of the Connecticut so as to strike the vicinity of St. Johnsbury; here it crosses the river, turns southward and follows the course of the Green Mountains as far as their highest elevations in north-western Massachusetts, turning around which the line returns due north, past the whole length of Lake Champlain, and then with a slight easterly bend crosses the St. Lawrence not far above Quebec; here it turns quickly to the west again, following the near

vicinity of the river. But to the west of the region thus enclosed the Canadian fauna includes the Adirondacks region, west of Lake Champlain. The southern margin of this broad interfaunal or bifaunal belt starts from some point in Massachusetts Bay not far southeast of Boston, and passes westerly in such a way as to include in the true Alleghanian fauna the entire belt of low lands along the southern coast of New England; but more than that it includes two considerable prominences thrust up the Connecticut and Hudson Rivers, as far north as Winsor and Poughkeepsie respectively. While just to the northwest of the latter the extended Canadian fauna embraces the Catskill region.

It will thus be seen that this great interfaunal or bifaunal belt sweeps across the whole of New England from west to east, and indeed embraces within its limits the greater part of its territory. As it passes from the west toward the sea an upper member follows north-eastward the valley of the St. Lawrence, but fails to reach the ocean; while the main belt, separated from the former by the great Adirondacks region, though narrowly connected with it along the valley of Lake Champlain, sweeps over the mass of New England; so that the study of the New England fauna becomes one of especial interest. If we study the relations of this interfaunal belt to the physical features of New England and the neighboring regions, we shall see that it is limited upon the north by a line which would run not far from a contour curve indicating a height of country of about eight hundred to one thousand feet; but that it is deflected to the southward by the great mountain elevations of the White Mountain area and the Green Mountain chain. In Maine it plainly skirts the line which in general separates the lower undulating country from the more broken, hilly regions of the north and it bears a similar relation to the southern edge of the Adirondack district; while its southern margin, as far as New England is concerned, is marked by the belt of lowlands which border the southern shore of the district, and is deflected northward only along the sea margin at its eastern extremity and up the valleys of southward flowing rivers.

In illustration of the different divisions referred to in the foregoing, we may point out that the upper margin of this belt marks in a general way the southern limits of such species of the Canadian fauna as *Oeneis jutta*, *Polygonia gracilis* and *satyrus*, *Eurymus interior*, *Pamphila mandan* and *Erynnis manitoba*; while *Polygonia faunus*, *Aglais milberti*, and *Cinclidia harrisii* extend further south so as to reach the true separating line of the Canadian and Alleghanian faunas; *Cercyonis nephele*, *Basilarchia arthemis*, *Eugonia jalbum*, *Cyaniris pseudargiolus lucia*, *Pieris oleracea* and *Amblyscirtes samoset* extend even further than this, often to the restricted limits of the Alleghanian fauna. *Basilarchia proserpina* (*astyanax-ursula*) and the hybrid transitional forms between *Cercyonis nephele* and *C. alope* are principally confined to this belt.

Turning to the more abundant Alleghanian fauna, we may note that no inconsiderable number of species pass northward even to the restricted limits of the Canadian fauna, such as *Cissia eurytus*, *Polygonia interrogationis*, *Anosia plexippus* (in its yearly excursions) among Nymphalidae, while *Cercyonis alope* barely fails of reaching it; among the Lycaenidae, *Incisalia nippon*, *Uranotes melinus*, *Thecla liparops* and *Everes comyntas*; and among the Hesperidae, *Thorybes pylades*, *Thanaos persius*, *icelus* and *brizo*, *Pholisora catullus*, *Amblyscirtes vialis*, and *Limochores taumas*. On the other hand the natural limits of the bulk of the Alleghanian species will be found to fall rather at the true middle line which we have pointed out. Such species are *Basilarchia astyanax*, *Speyeria idalia* and perhaps *Hypatus bachmanii* of the Nymphalidae; *Incisalia irus*, *Mitura damon*, *Thecla ontario*, *edwardsii* and *acadica* among Lycaenidae; *Euphœades troilus* among the Papilionidae; and among the Hesperidae, *Epargyreus tityrus*, *Thanaos lucilius*, *martialis*, *juvenalis* and *horatius*, *Ancyloxipha numitor*, *Poanes massasoit*, *Atrytone logan*, *Erynnis sassacus*, *metea* and *attalus*, *Anthomaster leonardus*, *Thymelicus aetna*, *Limochores bimacula* and *manataaqua*, *Euphyes metacomet* and *verna*, and *Lerema hianna*. Here, too, will probably be found the dividing line (in those polygoneutic species which range far on each side of the line, as in *Heodes hypophlaeas*) at which the number of broods in the season change, one more brood occurring south of the line than north of it. The Alleghanian species which seem to find their northern limits at the southern borders of the broad belt are *Junonia coenia* and *Euptoietia claudia* among the Nymphalidae; *Xanthidia nicippe*, *Eurema lisa*, *Anthocharis genutia*, *Pieris protodice* and *Laertias philenor* among the Papilionidae; and among the Hesperidae, *Achalarus lycidas*, *Thorybes bathyllus*, *Thanaos terentius*, *Hylephila phylaeus*, *Atalopedes huron*, *Thymelicus brettus*, and *Lerema accius*. But in addition to this list there are other butterflies more properly to be considered members of the Louisianian fauna, which in their northernmost extension, creeping along the Atlantic coast, reach either quite to this line of demarcation or stop barely short of it. These are, among the Nymphalidae, *Neonympha phocion* and *Chlorippe clyton*; among the Papilionidae, *Callidryas eubule*, *Iphiclides ajax*, *Jasoniades glaucus glaucus* and *Heraclides cresphontes* in its recent extension; while among the Hesperidae may be mentioned *Eudamus proteus* and *Hesperia montivagus*.

Some remarks upon the other insects which find their delimitations in these same districts will be found in my paper on the distribution of the insects of New Hampshire in the "Geology of New Hampshire," Vol. I, where these lines of separation are marked in a somewhat different way from less perfect knowledge. It can hardly fail of notice that the faunal divisions as here laid down, plotted upon the same map with the isotherms projected by Professor Davis, agree in a somewhat striking way

with the course of these same isotherms. Yet each set of lines, those of the faunal areas and of the isotherms, was worked out independently of the other, and their somewhat remarkable agreement and yet failure to correspond in many points is a very striking fact. Many more observations upon the distribution of insects within this belt and in its vicinity are necessary before we can arrive at any satisfactory results, and construct a map with a proper degree of accuracy; but the present attempt shows very clearly that it is within the limits of New England itself that the greatest progress in our knowledge is to be looked for, and that upon New England naturalists devolves the duty of solving these zoo-geographical problems.

IV.

STUDIES ON THE EMBRYOLOGICAL DEVELOPMENT OF EUVANESSA ANTIOPA.*

BY CHARLES W. WOODWORTH, M. S.

There is a wondrous workshop here,
E'en in this dainty little pod,
Here that mysterious workman, Life,
Builds matchless temples to his God.

Embryology deals with all the phenomena of growth from the first beginnings of life until its close; therefore on account of the extent of the subject the present paper is necessarily somewhat fragmentary in its character. In order to make it as compact as possible we will confine ourselves to some of the earlier stages of development where some of the most interesting problems in the whole domain of science present themselves for solution. Embryology may be called the science of development. It treats of life in motion and in this respect differs from Histology which is essentially a "study in still life." It differs from Physiology by confining itself to a single function of living matter, growth.

*The material used in the preparation of this article consists of a small lot of eggs collected by Mr. Scudder and partly prepared by Mr. Houghton, another and larger lot taken by Dr. Dimmock and a third collected by myself near Fabyan's, White Mountains; also some specimens of the imago, part obtained by myself and part sent me by Mr. Scudder.

The method of preparation which seems to have given the best results is to kill by heating in water at 80° C. which fixes the tissues very well. Eggs must now be punctured with a sharp needle; this is essential in order that the reagents used may penetrate. The most satisfactory stains were Grenacher's borax

carmine and Czocher's cochineal. The latter is especially good; it is prepared as follows: Place 1g. each of cochineal and burnt alum in a mortar and reduce to a powder; add 100cc. of distilled water and boil until there is but 60cc., cool and filter; a few drops of carbolic acid should be added as a preservative. The hardness of the egg shell makes the egg very difficult to section, but if removed it is so delicate as to be almost certain to go to pieces during the further manipulations. The paraffin method of imbedding was employed, and the sections cut on the rocking microtome made by the Cambridge Instrument Co.

It is a law in this world that all things have a lowly origin. The evolution of all living beings from simple unicellular germs is an established fact of science. The egg is generally looked upon as the simplest condition of the animal. At least in insects, however, there seems to be an earlier and simpler condition than is found in the egg. Here we should make the primitive egg cell in the terminal chamber of the ovariole, or in the primitive ovary before the ovariole is developed, the starting point in the study of embryology. This idea may be objected to on the ground that the egg cell is not complete until after the reception of the male element, and that only after that is accomplished do we have a cell capable of reproducing the species. The force of such an objection is more apparent than real when one recollects that in some insects, notably in the saw-flies and the honey-bee, eggs develop without the help of the male element. The eggs of some insects (viviparous plant-lice) are incapable of leading an independent existence and continue to receive food and grow.

The ovary of an insect is at first a simple mass of similar cells, originating as described below and remaining for a more or less extended period of time apparently without change, except that it becomes surrounded by an investment of connective tissue. The cells are now said to fuse so as to form a syncytium, but this I am inclined to doubt; indeed some studies on which I am engaged on other insects give me every reason to doubt it, though a few of the critical stages are still unknown to me. The evidence is this: the oldest ovary in which the ovarioles are not yet developed still consists of distinct cells, and the youngest ovariole known to me has in the lower end of the end-chamber far more distinct egg cells than enough to account for all the eggs that can be subsequently developed by that ovariole. The upper end of the end-chamber may be a syncytium and in some of the older ovarioles of some insects the whole end-chamber seems to be converted into one, but this appears to be a secondary condition. It is a point worthy of attention in studying the ovarioles of insects, that before the largest egg has attained any considerable size all the cells that produce eggs have been differentiated enough to be certainly recognized as egg cells. The study of the earliest stages of the egg must be carried on in the larval and pupal stages and not in the adult insect.

Besides the cells that go to make up the syncytium there are three kinds of cells in the ovariole of the group of insects to which *Eu Vanessa* belongs, the egg cell proper, the epithelium cells and the nutritive cells. They are all derived from the indifferent cells of the primitive ovary and are homologous structures. When the butterfly emerges from the pupa the ovarioles are already quite well developed. They consist of long slender filaments made up by the repetition of an oval unit, the egg chamber; these egg chambers constantly diminish in size towards the end-chamber

till finally they loose their characteristic shape and appearance and look like an unarranged mass of cells. In structure there is also a regular variation. At the lower end of the end-chamber upon careful examination one will notice that there are three kinds of cells present in the mass where at first sight they appeared to be all alike. In some the nucleus is clearer and the nucleolus more distinct; these are the egg cells. Two or three times as abundant and often slightly larger are the nutritive cells. The epithelium cells are quite inconspicuous and often hardly so numerous as the others; they are somewhat smaller in size and the nucleoli are hardly visible.

The egg chambers are formed through the rapid multiplication of the epithelial cells, forming a columnar epithelium on the sides of the egg cell (63: 1, ep) and enveloping with a thinner layer the adjacent nutritive cells. In insects having a large number of nutritive cells quite a number of epithelial cells remain in the spaces between the nutritive cells and retain their primitive appearance and size. As the nutritive cells grow they do not increase in numbers, at least in this insect, but attain a very large size. The nucleus increases in size as rapidly as the cell does and becomes irregular in outline and the contents coarsely granular. After the egg chamber has attained nearly the size of the fully formed egg the nutritive cells begin to decrease in size, due to the parasitic action of the egg cell, and finally are reduced to a very small mass of debris. The egg cell increases from the first as rapidly as the nutritive cells but the history of the nucleus is quite different. This body increases greatly in size but the relative proportion between it and the cell is constantly decreasing; it occupies a position on one side and near the upper end of the cell; it is a clear, transparent vesicle with a very distinct nucleolus. When the egg approaches maturity and has absorbed the nutritive cells a change ensues in the nucleus that is very important: first, the nucleolus becomes paler and disappears; then the outline of the nucleus become indistinct, and finally no trace of nucleus is observable in the egg; the nuclear matter has diffused itself in the egg and it is a question whether part is not still nucleus, though not recognizable as such. This hypothesis is the most reasonable, though the spontaneous production of a nucleus under proper conditions is by no means impossible, for such a process must have occurred back in the dawn of creation when organic matter first developed this structure.

The epithelial cells vary a great deal in appearance and shape according to their position. Between the chambers (63: 1, 2) they are disk-shaped, showing a spindle shaped section; on the sides of the egg cell they form a regular columnar epithelium; around the nutritive cells they make a sort of epithelium but not regular as around the egg cell; at the plane where the egg and nutritive cells touch, the epithelium begins to infold, forming

a very thin and delicate septum composed of two layers ; this membrane never entirely separates the egg cell from the nutritive cells, but leaves a small hole through which projects a process of the egg cell for the purpose of obtaining food from the nutritive cells ; it is known as the nutritive process (63 : 2 np).

Over the whole outside of the ovariole there is a very distinct firm membrane, the tunica propria (63 : 1, 2 tp), which is produced by the epithelium as a sort of cuticle. Outside of this the peritoneal membrane may be seen (63 : 1 p) ; it is of mesodermic origin. In the stage represented in fig. 2 the epithelial cells have become flattened laterally and arranged themselves in rows corresponding to the future ribs of the egg shell which is produced by them.

Though the butterfly emerges in the autumn, the eggs are not deposited until quite late in the following spring, so it will be seen that the development is comparatively slow. The large number and the simultaneous development may account for it. I had the good fortune to observe the insect in the act of oviposition. It was about noon of a sultry day, which had become quite cloudy and was threatening rain. Along the side of the road some willows had grown up like shrubs, perhaps six feet high ; on one of the upper stems I noticed the butterfly standing on the stem with her wings closed back to back ; she allowed me to approach till my head was within two feet of her. She moved her abdomen from side to side depositing the eggs in a row at the rate of about five or six a minute ; now and then she would move forward in order to accommodate the length of her abdomen to the point where she was depositing. I watched her while she was laying perhaps one-third of the mass ; at first she seemed to pay no attention to me although I was so close, but finally, probably on account of my moving, she seemed to become restless, laid quite a number of eggs on top of the others, and then without warning was off. I cut the stem at once and noticed on the mass of eggs a little Hymenopterous parasite* which seemed to be depositing eggs also. It would run across the egg mass, then pause a moment or two over two or three eggs in succession, and then be off to another part of the egg mass and repeat the performance. The specimen was preserved and some of the eggs allowed to hatch but no trace of parasitism appeared in them. The stem on which this egg mass was laid is almost a quarter of an inch in diameter and the mass covers at least half inch in length, and is the largest mass laid by this species of which I have ever heard.

The egg, as already remarked, is apparently without a nucleus and it suggests the question : What is the function of the nucleus ? Is it the motor power that impels the cell to the exercise of its functions ? If such, it would seem that the nucleus had induced the protoplasm with such

* This has been determined by Mr. Howard as *Telenomus graptæ* (89 : 9).

a food-gathering mania that it had at last itself fallen victim to its own devices. Is the nucleus merely passive in this respect? Then it grew with the cell's prosperity till it had reached a point where its organization was not enough to hold it together.

The egg, after the disappearance of the nucleus, is no longer a cell in the sense it was before; it has not the organization of a cell; it is the remains of what was a cell. It is a mass of yolk surrounded and imbedded in live protoplasm. But this protoplasm exhibits no harmonious action for the accomplishment of one end; it lacks the interrelations necessary to a unit like a cell. Its history shows more fully the truth of this conclusion. The earliest stages of its future development are unknown, but as in other insects a certain nuclear substance makes its appearance and forms a very small nucleus, which, as recently shown by Blochman, gives off the polar globules, as occurs with other animals, and forms the female pronucleus. About the time of fertilization this sinks into the yolk; a small amount of protoplasm gathers around it, partly the original protoplasm and probably partly that which has been produced from the degeneration of the yolk spherules by the ordinary process of cell growth. This nucleus and the protoplasm around it constitute a distinct and complete cell. Division sets in and a number of cells are produced. Each of these is a complete cell, with plasma and nucleus, and the only relation that the yolk surrounding it has to it is that of food. The subsequent history is only the increase and development of these cells, and the consequent degeneration and absorption of the yolk. In the freshly laid egg there is inside the yolk membrane a layer of stainable protoplasm, in which are imbedded considerable numbers of small, spheroidal bodies, quite highly refractile, partly fatty and partly albuminous, but the main mass of the egg is made up of another structure, known as yolk spherules.

These are about .001 mm. in diameter, though varying between .0008 mm. and .0012 mm; their index of refraction is not very far from that of balsam; in color they are somewhat yellowish, and they do not take stains readily. By mutual pressure something of their spherical shape is lost, but they do not have flat sides; for those first formed are round, and the later ones conform to them and so have concave sides. As to the method of formation, we first see a very small granule, which grows gradually until the full-sized yolk spherule is formed. Whether this growth is merely accretion is not certainly known, but there is no indication of lamination; on the other hand there is no visible spherule membrane, as one would expect if the growth were due to intussusception. The method of degeneration is very interesting and reminds one of the fatty degeneration of the tissues of the pupa, or hystolysis. At the beginning of cell activity in the egg, certain of the spherules in the immediate neighborhood of the active cells begin to appear slightly granular; the granules are coarse but

very indistinct at first; this appearance does not begin at one point and spread over the spherule, but appears simultaneously over the whole spherule. These granules, which are from the first coarse, become more and more distinct and highly refractile, and finally the outline of the spherule is no longer discernible. The bodies produced are not fat, although they resemble it very much in optical qualities. They may be looked upon as a form of albumen most readily converted into cell food, while the yolk-like fat is a condition of the food material suited for storage. Yolk degeneration goes on with great rapidity, until about one-third of the mass of the egg has assumed this granular condition; this is at the time the newly formed blastoderm cells begin their migration towards the circumference, when a pause ensues. The degenerated yolk occupies the centre of the egg, and the blastoderm cells readily push their way through this material and pass into the part containing the undifferentiated spherules beyond. After the blastoderm cells have passed this line the yolk cells follow and carry with them some of the degenerated yolk, and finally produce the yolk masses as described below. The process of degeneration now takes a new start from the nuclei of the yolk cells and spreads gradually outward from each, until the whole mass has undergone this change. One of the most striking stages (63:5) is when the whole mass has degenerated, except a single row of spherules around each cell. The degeneration of the yolk is not complete till quite late in the development of the insect. Some recent authors have described bodies in the yolk spherules of insects, which they call bacterioids, attributing to them certain bacteria-like action. Their method of appearance, however, seems to exclude the possibility of their being anything like organisms growing in the yolk.

The earliest stage known in the development of the egg is when there are about twenty cells present. These are about uniform in size and all at quite a distance from each other, for at this stage as soon as a cell divides the resultant cells separate. This is facilitated by the degenerated condition of the yolk spherules in this region; the cells are ameboid in shape and the nucleus very indistinct, but of considerable size; after dividing several times the cells arrange themselves in line and commence a migration towards the circumference. In going through the degenerated yolk they sometimes leave trailing out behind them a long process (63:3) of protoplasm; on reaching the edge of this region they pause, gather themselves together, and plunge into the mass of undifferentiated yolk. While in transit, the cells divide so as to keep about the same distance apart; they do not all reach the edge at the same time, but those on one side take their station long before the others (63:4). On reaching the protoplasmic layer the cells at once appropriate that immediately before them and so increase rapidly in size. Owing to the granular mate-

rial in the absorbed protoplasm the cell plasma becomes darker and the still unaltered nucleus becomes very distinct. On the outside of the protoplasmic layer there was a layer of grayish material; this now forms a cap over each cell and extends down each side for a considerable distance. When all these cells have reached the circumference of the egg the blastoderm may be supposed to be fully formed, though at no time do all the cells that form it resemble each other; some commence their further development before the others reach their proper position; the blastoderm is complete about twenty-four hours after deposition. Besides the blastoderm cells there are in the centre of the egg a large number of other cells, mostly yolk cells; they have no definite arrangement but are pretty evenly distributed over the whole egg.

The blastoderm cells on one side of the egg continue to divide so that when the blastoderm is complete the cells on one side are much smaller in diameter than on the other; they have, however, increased in thickness and so make a thicker and more compact layer; this is the beginning of the ventral plate. The cells which make up this structure are at the bottom of the egg and extend half way up one side (63:10). The transition between this area is quite abrupt. In the further development the ventral plate sinks deeper into the yolk. This is accomplished within three days after deposition. The first indication of the process is a slight infolding of the upper end (63:10); the blastoderm cells begin to grow over the ventral plate from this point and extend down the sides; the edge of the ventral plate sinks down at the same time. During this process of infolding the whole ventral plate begins an upward movement and increases somewhat in size; when the infolding is complete, that is, when the outfolded edges of the blastoderm cells have met and closed over the whole ventral plate, the latter is about as long as the egg but so curved as to reach only about three-fourths way to the top (63:11). It will be seen that the embryo has now two layers of cells outside of it, one extending all around and the other only across the outside face of the ventral plate; between these two layers the yolk penetrates freely. Great confusion exists as to the nomenclature of these membranes but I prefer to follow Balfour in this matter and designate the inner as the amnion and the outer as the serous membrane, though the reverse is perhaps the more common practice. From this history of their formation it is evident that both layers and the ventral plate are modified blastoderm cells, and that the membranes can in no sense be called moultings of the ventral plate.

We will leave the embryo at this point and conclude by giving an account of a few structures that have already made their appearance, but which have not as yet been noticed by us. One of these is a peculiar condition of certain of the blastoderm cells at the upper pole of the egg; it

is quite common if not universal in the eggs of insects, as one can perceive by examining the figures of young insect embryos by various authors. No one, as far as I can make out, has expressed any opinion as to their significance or function, nor can I. Very early in the formation of the blastoderm, certain of the cells in the upper end fuse together and form a syncytium; their nuclei are large, and the whole mass is larger than an equal number of blastoderm cells, even of those in the ventral plate in the time of their maximum size; beneath them the yolk assumes a peculiar condition possessing bubble-like cavities.

The yolk cells constitute another of those structures which we may call temporary; they perform the very necessary function of preparing the food material out of the yolk. It has not been proven that any of them take any part in the formation of the tissues of the insect, and many of them certainly do not; at first they resemble very much the cells that go to make up the blastoderm, but may be distinguished by their affinity to the yolk, or rather by the fact that they absorb the yolk spherules and granules bodily; shortly after blastoderm formation they complete their absorption of the yolk and are called yolk masses, but may with strict propriety be still called yolk cells. The method of yolk degeneration that these cells set up has been already described. There are other cells in the mass of the egg which do not take part in the degeneration of the yolk; they appear as indifferent cells of the earlier stages, and probably give rise to the endoderm. Others find their way to the ventral plate and lie close against it; these appear to give rise to the mesoderm, though this is not the view generally received as to the origin of this germ layer.

About the time of the completion of the blastoderm the already differentiated ventral plate infolds at a point on the median line about two-thirds from the upper end and forms a very narrow pocket. The cells composing it look like the rest of the cells of the ventral plate at this time; they are almost round and have a lining on one side made of the gray matter which originally bordered the whole egg but which became a part of the blastoderm cells. The pocket remains open but a short time, but there is a long depression at the upper end of the bunch of cells; the mass of cells are soon cut off from the ventral plate and are free in the body cavity, but remain in contact with the ventral plate at the point where they were produced. Later stages show that these cells produce the generative organs; the generative organs thus appear to be produced by an infolding of the ectoderm, or possibly of the blastoderm before the ectoderm is produced, but from a portion which is later to become ectoderm. The general idea has been that the generative organs in insects are produced from the mesoderm, although Metschnikow as early as 1866 showed for certain insects a different origin.

This brings us face to face with an unsettled question of fundamental

importance in embryology. "If there are any structures," says Balfour, "whose identity throughout the Metazoa is not open to doubt, these structures are the ovum and spermatozoon"; and though embryologists regard the germinal layers as presenting homologies almost equally certain, it is nevertheless the fact that observation indicates that the ovaries in the different groups arise from different germinal layers. This fact even led Balfour to doubt the fundamental importance of the germinal layers. It is worth while to review what is known of the origin of the primitive ova in the various groups of animals. In the Spongiaria certain of the cells of the general parenchyma are said to develop into eggs and so they would be considered mesoblastic; the Cnidaria exhibit considerable apparent variation, but, as the primitive ova cannot be distinguished from the other cells and as they are known to migrate from one layer to another, it is extremely doubtful if anything can be made out with certainty about them; in the Annelida the ova arise from cells situated in the lining of the body cavity; in the Nematelminthes the generative cells have been observed in the gastrula, where they lie in the hypoblastic lining of the archentron, but later they are free in the body cavity; in the Polyzoa they are apparently mesoblastic and situated in the space between the stomach and the floor of the vestibule; a single cell in the mesoderm gives rise to the generative organs in the Nematodes; with Insects the primitive ovaries are a mass of cells situated at the end of the proctodeum and said by some to arise from it, by others to be derived from the mesoderm, while still others trace them back to certain so-called pole cells which originate before the blastoderm is formed; in the Crustacea the cells giving rise to the generative organs arise during segmentation and are first enclosed in the epiblast and still later migrate inwards; in Vertebrates the germinal cells are first seen in the so-called germinal epithelium from which they seem to have arisen.

It is thus seen that a great difference appears in the various groups. The only view that appears to reconcile all these statements is this: The germinal cells do not belong to any layer but are the product of some of the first divisions of the egg cell; they take part generally in the formation of the blastoderm and then migrate into the mesoderm. Probably in most animals, as in *Euvanessa*, they are indistinguishable from the other blastoderm cells. In only a few animals have the germinal cells been traced back cell by cell to the egg cell and these cases entirely support the view here advanced. In all cases where they are supposed to come from the mesoderm the later stages, comparatively, are the only ones known.

As the life history of any animal constitutes a cycle, so does the embryology: while all the other tissues of the adult animal are more or less differentiated for their several functions, certain cells of the ovary retain

the primitive condition and have the potency within themselves under the proper conditions of forming another animal of the same species. As embryology is purely a science of cells, the student should not be satisfied until he can trace cell by cell the cycle of development from ovary cell through the egg cell and back to ovary cell again—the embryological cycle. A three-fold division might quite properly be made of Embryology. Oogenesis, treating of the development of the egg from the ovary cells; Ovarigenesis, completing the cycle and treating of the formation of the essential elements of the ovary; and third, the great subject of Organogeny, which deals with the main portion of the science.

THE FAMILIES OF BUTTERFLIES.

. . . Those waved their limber fans
For wings, and smallest lineaments exact
In all the liveries deck'd of summer's pride
With spots of gold and purple, azure and green.
MILTON.—*Paradise Lost*.

BUTTERFLIES are those scaly-winged insects with a spirally coiled tongue formed of channelled and united maxillae, which usually fly only by day, have sexually uniform antennae terminating in a more or less distinct club, with scarcely an exception lack ocelli and the curved bristle serving in moths to connect the front and hind wings near the base, and usually undergo their transformations in the open air, without spinning an encircling cocoon.

They form the highest members of the order Lepidoptera and are separable into four families, which may be distinguished at any stage of life by the following table.

1. *Imago* of variable size, usually rather slender, with ample wings. Head in a vertical plane, the tongue being inserted opposite the lower half of the eye. Antennae approximate at the base, the space between them not equalling half the vertical diameter of the eye, the tip of the club rarely curved and never produced to a distinct point. Eyes with no overhanging pencil of bristly hairs, though in rare cases (some Lycaeninae) a small tuft of hairs occurs at the base of the antennae; cornea of eyes not extending over the posterior fourth of the ocellar globe. Front tibiae rarely (Papilioninae) with any epiphysis, and hind tibiae with only terminal spurs. Inner edge of hind wings rarely (Papilioninae) plaited, but extending beneath and partially embracing the abdomen; fore and hind wings in repose resting in the same plane. *Egg* either distinctly higher than broad and then vertically ribbed; or sub-globular and then smooth or reticulate; or broader than high and then usually echinoid or tiarate. *Caterpillar at birth*.—Head usually broader and higher than the body; the latter either with ranged appendages (of various shapes) generally longer, often much longer, than the segments; or with fleshy tubercles, especially on the thoracic segments. First thoracic segment with no distinct corneous dorsal shield, though a feeble one exists in some forms, and especially in the Lycaenidae. *Mature caterpillar* variable in form, but generally cylindrical, often spinous, never with a strongly contracted and distinct neck, and without distinct thoracic shield. Generally constructing no place of concealment. *Chrysalis* generally (excl. Lycaenidae) more or less angulate or with projecting shoulders, very rarely (in our species never) enclosed in a cocoon.

A. *Imago*.—Front not only occupying the face, but extending also over half the crown of the head, and separated from the occiput by a distinct (in *Anosia* slight) transverse furrow between the antennae. Base of the antennae wholly separate from the inner edges of the eye. Prothoracic lobes tolerably large and above tumid. Wings with the outer margins usually crenulate, dentate, sinuate, or angulate; front pair with two inferior sub-

costal nervules, originating at the extremity of the cell; inner margin of hind wing always embracing the abdomen. Tetrapod, the fore legs being unused and atrophied, especially in the male, but in both sexes the terminal appendages of the last tarsal joint absent (excepting in Libytheinae, where the claws are present in the female), and both spines and spurs of tibiae obsolete. *Egg* either reticulate and then sub-globular, or else vertically ribbed and generally trellised over at least the upper half of the egg, and then never more than one-half as high again as broad (with the possible exception of the Libytheinae). *Caterpillar at birth*.—Head generally larger, never smaller, than the thoracic segments and generally scabrous; when of the same size, the corneous crown of the head is never encroached upon by the integument of the first thoracic segment, and the body is covered either with series of very long hairs (in which case most of them are acicular and not clubbed at the tip) or with extremely short and distant acicular hairs. *Mature caterpillar* generally cylindrical, the head usually held in a vertical position, larger than the segments behind it, free and posteriorly contracted. Body furnished with continuous rows of spines or smooth lenticles, or with discontinuous rows of fleshy tubercles, or with short pile; in the last case either the head is tuberculate or the last abdominal segment is furcate, or both, or the segments have but four transverse and nearly equal divisions. *Chrysalis* generally angulate, often strongly angulate, or if rounded, with shouldered prominences. It always hangs in a reversed position by its tail alone, except in the rare case of a few Satyrinae, which are rounded, without special prominences, have no cremastral hooks, and undergo their changes in a crevice upon or a cell in the ground, the head as high as or higher than the hinder end.

Fam. I.—**Nymphalidae.**

B. Imago.—Front occupying but little more than the face and separated from the occiput by a slight suture between the antennae. Bases of antennae inserted in distinct sockets, which either clearly infringe on the inner edge of the eye, or are open next that edge. Prothoracic lobes minute, generally appressed to a mere lamina. Wings with the outer margin generally entire, especially in the fore wing, but the hind wing often tailed; fore wings with only one inferior subcostal nervule, arising at the extremity of the cell; inner margin of hind wings generally but not always embracing the abdomen. Hexapod, the front legs being employed in walking, and not atrophied excepting in some males (Lycaenidae, esp. Lemoniinae), where they are partially atrophied, and sometimes have the tarsi reduced to a single unarmed joint. *Egg* either smooth, or else reticulate (and then fariate or hemispherical), or else vertically ribbed and trellised (and then greatly elongated, nearly or quite twice as high as broad). *Caterpillar at birth*.—Head always smaller or no larger than the thoracic segments and usually smooth; when of the same size, either the corneous portion of the crown is partially replaced by the integument of the first thoracic segment (that is, the cranium has no posterior surface), or the body is furnished with very long or very short hairs, almost all of which are clubbed at the tip. *Mature caterpillar* cylindrical, or anteriorly enlarged, or onisciform. Head usually held in an oblique position, generally small, contractile and posteriorly incomplete. Body never furnished with spines, but either naked, or furnished with ranged filaments or discontinuous rows of tubercles (in which case the head is always smaller than the succeeding segments), or with short pile (when the head is uniform, the last abdominal segment entire and the segments divided transversely into six or more sections), or with fascicles of longer hairs. *Chrysalis* angulate or rounded, often with no prominences whatever. It hangs in various positions, but is always attached not only by its tail, but also by a silken girth around the middle, and in rare cases is also enclosed in a feeble silken cocoon. Some few tropical Lemoniinae are said to lack the transverse girth, but to retain the normal position by the immobility of the abdominal segments.

a. *Imago* of small size and delicate structure. Front of head between the eyes much narrower than high. Eyes not projecting beyond the general contour of the head, notched on the inner margin, to give room for the antennal sockets. Antennae including the club straight. Metathorax only slightly separated from the mesothorax. Median cell of fore wings closed by a weak vein; median nervure of hind wings with three branches; the inner margin never plaited. Fore legs with no tibial epiphysis, sexually heteromorphous, the tarsi of the male being more or less atrophied. Dorsal margin of the eighth abdominal segment of male entire. Upper organ of male genitalia with long, slender, strongly curved, lateral appendages. *Egg* tiarate or hemispherical, and more or less deeply reticulate. *Caterpillar at birth*, so far as known, furnished with numerous long, tapering hairs and with naked chitinous annuli, both arranged in longitudinal series. *Mature caterpillar*, so far as known, either onisciform, subonisciform, or cylindrical; the body furnished with scattered coarse and scant pile, among which are some serially disposed bristles or fasciated hairs; or in some exotic forms with stout fleshy processes longitudinally disposed. *Chrysalis* usually short and stout, always bluntly rounded in front, the body rarely furnished with projections, and these invariably rounded. Medium girth always close to the body at all points, the ventral surface of the body lying in a nearly uniform plane. Cremaster not at all or but slightly protuberant, the hooks inferior or apical. (A single exception occurs in *Fenisea*, but here the cremaster is broader than long and the hooks wholly inferior.) . . . Fam. II.—**Lycaenidae**.

b. *Imago* of medium or large size. Front of head between the eyes as broad as high. Eyes prominent, not infringed upon by the antennal sockets. Antennae straight, or, especially the club, sinuate. Metathorax markedly separate from the mesothorax. Median cell of fore wings closed by a strong vein; median nervure of hind wing with three or four branches; the inner margin sometimes plaited. Fore legs of both sexes as complete as the other pairs, sometimes with an epiphysis on the inner side of the tibiae. Dorsal margin of the eighth abdominal segment of male notched or produced to a hook. Upper organ of male genitalia with no lateral processes. *Egg* subglobular and smooth, or very much elevated and vertically ribbed and trellised; (one known exception occurs in *Parnassius*, in which it is tiarate, but where, in contradistinction to the *Lycaenidae*, it appears to be overlaid with raised polygonal plates). *Caterpillar at birth*, so far as known, furnished with longitudinal series of clubbed or forked hairs or with prickly tubercles. *Mature caterpillar* cylindrical or enlarged anteriorly, covered with very short pile (in some exotic forms with long hairs), mostly arranged in transverse rows, or with rather infrequent and irregularly distributed microscopic hairs, and often also with series of fleshy tubercles or filaments, or glabrous, scarcely elevated lenticles. *Chrysalis* elongate, unimucronate or bimucronate in front, generally with numerous angular projections. Median girth often free from the body for a considerable part of its course by the ventral extension of the wing sheaths, the ventral surface of the body being generally bent more or less strongly near the middle. Cremaster strongly protuberant and free, the hooks apical.

Fam III.—**Papilionidae**.

II. *Imago* of small or medium size, usually robust, with rather small wings. Head in a horizontal plane, the tongue being inserted opposite the middle of the eye or even higher. Antennae widely separated at the base, the space between them more than equalling half the vertical diameter of the eye, the tip of the club more or less distinctly pointed and recurved. Eyes usually overhung at the outer base of the antennae by a curving pencil of bristly hairs; the cornea extending over almost the entire ocellar globe. Almost invariably the front tibiae have a foliate epiphysis on the inner side, and the hind tibiae a middle pair of spurs in addition to the

terminal pair. Inner edge of hind wings plaited, the fore and hind wings in repose often resting in different planes. *Egg* never noticeably higher than broad, and either hemispherical and smooth, or domed, vertically ribbed and trellised. *Caterpillar at birth*.—Head always broader and higher than the body, the latter with ranged fungiform appendages, never, excepting on the seventh and eight abdominal segments, so long as the segments. First thoracic segment with a distinct corneous dorsal shield. *Mature caterpillar* cylindrical, but slightly flattened beneath and stoutest in the middle, never spinous, generally minutely and coarsely pilose, with a large head, slender neck, and a transverse corneous shield on the upper surface of the first thoracic segment. With rare exceptions (among tropical forms) living in concealment. *Chrysalis* smooth and uniform, rarely with a mucronate head, always enclosed in some sort of a cocoon.....Fam. IV.—**Hesperiidae**.

I.

FAMILY NYMPHALIDAE.

BRUSH-FOOTED BUTTERFLIES.

Nymphalidae Swains.;	Nymphales Linn.;	Heteropodes Hoffm.
Nymphae Borkh.;	Nymphalidi Boisd.;	Chilopodiform or Scolopendriform stirps
Nymphalia + Festiva Grav.;	Nymphaliens	Horsf.
Blanch.-Brullé;	Nymphalii Lucas.	Suspensi Boisd.;
Papilionida (pars) Leach;	Papilionides (pars)	Suspensa (pars) Gerst.
Bilb.;	Papilionidae (pars) Sam.;	Pendulae Boisd.
Papilionites (pars) Newm.		Detegentes (pars) Newm.
		Fusifformes (pars) Guen.
Tetrapodes Dalm.;	Tetrapii Guen.	

The insect legions, prank'd with gaudiest hues,
 Pearl, gold, and purple, swarm'd into existence.
 Minute and marvellous creations these.
 . . . some proudly shone
 Like living jewels; some grotesque, uncomely,
 And hideous . . .
 Those lived deliciously on honey-dews,
 And dwelt in palaces of blossomed bells.
 Millions on millions, wing'd and plumed in front, . . .
 Fill'd the dim atmosphere with hum and hurry.
 MONTGOMERY.—*Pelican Island.*

Imago. Ordinarily of medium or large size. Head pretty large, apart from the eyes compact, full, of nearly equal dimensions; front well developed, full, not far from square but usually broader than high, occupying nearly the whole anterior face of the head and nearly or quite half of the summit, its lower outer angles slightly truncate, the upper posterior border descending to meet the occiput, with which it forms a transverse channel between the antennae,—reduced in the Euploeinae to a mere furrow; occiput not greatly developed, although sometimes quite protuberant, of varying shape but almost always broader than long and occupying one-half the summit. Tongue inserted opposite, or a little below, the middle of the lower half of the eye; papillae of tongue long and slender, usually appressed, often swollen in the middle or toward the tip, with a blunt rounded apex, bearing a smaller short central process, often surrounded by five exceedingly delicate thorns, nearly or quite as long as itself,—the extension of the then longitudinally ribbed sides of the main papilla; they are attached to the under surface of the tongue near but not upon the outer edge, and are confined to the terminal fifth or less; they are usually closely crowded in a single row, but sometimes are slightly separated and in the higher forms are placed in crowded double rows; at the extreme tip of the tongue they form a little cluster both above and below and here are usually smaller and less slender than elsewhere. Eyes prominent. Antennae inserted near together, not infringing on the eyes and placed entirely within the sides of the front, furnished with a straight or drooping club.

Prothoracic lobes pretty large and timid. Thorax pretty stout, the upper surface considerably arched, the anterior sides of the mesoscutellum projecting some-

what sharply between the halves of the mesoscutum at about a right angle, the suture between the two forming a pronounced sulcation, the posterior curve, formed by the two together, elliptic. Metathorax separated rather prominently from the mesothorax. Wings of every variety of shape found amongst butterflies. Fore wings: costal nervure terminating near the middle of the costal border; subcostal nervure with four superior and two inferior simple branches, at least one of which is emitted before the end of the cell,—itself terminating quite near the apex of the wing; the discoidal cell may be either closed or partially open and is of moderate width; median nervure with three branches, itself not reaching the border; internal nervure, when present, very short and running into the submedian nervure. Hind wings: costal nervure terminating between the middle and the tip of the costal border, emitting from near the base an upward directed branch, curving inward or outward or Y-shaped at the tip; subcostal nervure with three branches, itself not reaching the border; the discoidal cell either open or closed; median nervure with three branches, itself not reaching the border; submedian nervure usually terminating at the anal angle, sometimes on the outer border; internal nervure usually terminating on the inner border, sometimes at the anal angle. Inner margin expanded, embracing the abdomen beneath. Fore legs atrophied, especially in the male; but in both sexes, the claws and other terminal appendages of the last tarsal joints (excepting in the *Libytheinae*, where the claws, etc., are present in the female tarsus) and both spines and spurs of the tibiae are obsolete; the spines and sometimes the spurs of the tarsi are also absent; in some males, the tarsi are not even divided into joints and they are always unarmed.

Last dorsal segment of the male abdomen (excepting in the *Libytheinae*) entire above, the upper organ generally stout, with or without lateral arms, and provided with an elongate, tapering, pointed median hook (in *Libythea acicular*), or if bifurcate only minutely excised at tip; clasps forming lateral, lamellate, more or less convex plates very variable in shape, proportion and armature.

Egg. Globular or dome-shaped, the surface marked either with polygonal cells (whose walls may be either slight or prominent), or else furnished with a number of raised longitudinal ribs, usually extending over the whole egg, but sometimes confined to the upper half and with much more delicate cross-ridges.

Caterpillar at birth. Head generally larger, never smaller, than the thoracic segments and usually roughened, and always with a greater or smaller number of hair-emitting papillae; never encroached upon by the integument of the first thoracic segment. Body cylindrical, often tapering from in front backward, but rarely if ever from the middle forward, furnished with longitudinally ranged cuticular appendages of various shapes, generally longer than the segments and often more or less clubbed, some of the series shifted in position in passing from the thoracic to the abdominal segments; first thoracic segment with no distinct corneous dorsal shield.

Mature caterpillar. Head free, furnished to a greater or less extent with hairs and sometimes with spinous processes. Body nearly or quite cylindrical, long and slender, equal or tapering toward either or both ends; or, single segments may be swollen wholly or in part, and then the caterpillar becomes distinctly mouliiform; simply furnished with short hairs or bristles arising from minute papillae, or else supplied with unequally or regularly distributed spines or fleshy tubercles; spiracle of the eighth abdominal segment on a line with the others.

Chrysalis. Either suspended by the posterior extremity only, head downward, or, in rare instances, with no fastenings whatever, transforming in an imperfect cell upon or beneath the ground, with little or no silken lining. The chrysalis is comparatively long and slender, enlarged in the middle and tapering, generally to a considerable extent, at either end; head advanced in front of the prothorax; ocellar prominences double, nearly always present at the side of the head; abdomen, with rare exceptions, destitute of a lateral ridge; cremaster stout, protuberant, the hooklets at tip moderately long and rather slender (in rare cases aborted), their apical portion thickened equally, or sometimes compressed, bent over like a crook, the apex conical.

General characteristics of the family. This most extensive as well as highest family of butterflies is spread over every portion of the globe; although its maximum of development is reached in the tropics, its relative numerical superiority is most evident in temperate regions, and especially the north temperate zone of the old world where its numbers nearly equal all other butterflies combined. Although it has long been placed in a subordinate position, it is now generally considered by most philosophical entomologists to hold the highest rank among Lepidoptera,—a position which was long ago given it by some of the early students of butterflies, but one which could not make head-way against the Linnean traditions. The atrophy of the front legs of both sexes, found only in this family and possessed by every member of it excepting the insignificant and aberrant group at its foot, and the suspension of the chrysalis by the tail only, first recognized by Dalman and which suggested to Boisduval the name *Suspensi* long in use, are sufficient by themselves to prove that to this group must be assigned the highest rank. For in the passage of the individual from the larval stage to the perfect form the segment bearing the front legs has in all Lepidoptera become constantly reduced in size; and the atrophy of the legs borne by this segment, found in some groups and not in others, must be considered an evidence that a difference characteristic of change from a lower to a higher grade of life is also a characteristic of the passage from a lower to a higher grade of structure. Moreover, as I have already pointed out in discussing the general classification of butterflies, the chrysalids which hang by their tails only show, in the straight ventral surface of the abdomen of the vast majority of them, that they are descended from butterflies which in their chrysalis stage were also girt about the middle.

Although other families contain butterflies which vie with the Nymphalidae in lustrous beauty, this largest family contains upon the whole by far the greatest number and variety of striking forms, whether we consider the butterfly, the egg, the caterpillar or the chrysalis. Moreover, they are the forms which are most commonly seen and noticed by those who have but a popular interest in natural history, for they are the butterflies *par excellence* of the temperate zone, of the region where civilization has most flourished and the praises of nature have been most sounded by the poets. It is from the transformation of this group of butterflies that ancient mythology has drawn its inspiration. The very name chrysalis, the “golden thing” of the Greeks, was drawn from observation of this family, where alone the pupa often assumes a gilded hue. And it is not strange that they should have so observed them, for of all butterflies these are the most spritely and vivacious, the most audacious, most fond of propinquity to man and his cultivations, and endowed with most varied psychological traits; though at the same time the family contains some forms with the

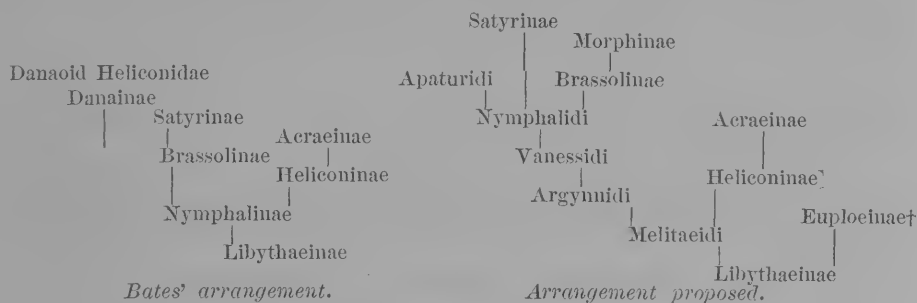
weakest flight known to butterflies. To this family alone, so far as human organs can perceive them, are confined the few sounds which are emitted by butterflies, consisting mostly of rustling and crackling, and evidently produced in some manner by the wings; in other groups, to be sure, certain movements of the wings suggest sound, but none apparently is produced, none certainly that can be heard by us. There is also here a greater variety of structure than is found in any of the other families of butterflies. We need only point out the fact that a considerable number of its subdivisions have been raised to primary rank by not a few naturalists. The coloring of the wings is also more varied than in other families, and more than in any other will one discover a striking difference between the coloring of the upper and under surface of the wings. As one departs farther and farther from the lower Lepidoptera in ascending the families of butterflies, one discovers a larger proportion of those which, when at rest, raise the wings above the back and expose only the under surface, instead of expanding the wings horizontally and so showing the upper surface, as in moths. It is therefore upon the under surface of the wings of butterflies that one should look for a greater variety of coloring than upon the upper surface, at least in the highest forms; and this is exactly what we find.

Here, too, occur the greatest number of cases of protective resemblance and of mimicry.

Nor is the interest especially attaching to this family confined to structure and coloring alone. In habits and in life-histories the diversity of the type is everywhere displayed. For there is scarcely any variation in the regular cycle of changes which every lepidopterous insect undergoes which is not found within the limits of this family, and many are confined entirely to it. They pass the winter in every possible stage excepting, so far as known, in that of the egg, but including in one or other group every stage of larval life. The caterpillars are more often social than in other groups. There frequently enters also an element of lethargy even in mid-summer. The behavior of caterpillars for their protection against their enemies is exceedingly varied and interesting, and the forms of shelter constructed for their concealment are equally varied. The mode of pupation is, as already stated, different from that of any other group, in that they hang by their tail alone, and in general quite freely, though there are a few instances, as *Cirrochroa* and to a certain extent *Chlorippe*, in which the pad of silk is so tightly woven to the surface upon which it is spun, and the cremastral hooks of the chrysalis are spread over so long a surface that the chrysalis, instead of hanging freely, lies with its ventral surface in close proximity to the surface of rest. The method in which they accomplish their transformations, from the caterpillar clasping the pad of silk with its anal prolegs to the chrysalis whose hinder end, armed with little anchor-like hooks, is withdrawn from the shrivelled skin of the caterpillar and

plunged into the same pad, from which it shakes off the now useless larval cuticle, is exceedingly interesting.

The division of the family. A word or two should be added in relation to the serial order of the groups here employed, as it differs in a slight degree from that given in the excellent sketch which Bates prefixed to his study of the heliconide Lepidoptera of the Amazons Valley. The principal difference consists in removing the Euploeinae* from their exalted position at the summit of the entire rhopaloceros series to a comparatively low one near the base of the Nymphalidae, and in closer relation to the Heliconinae, etc. Our reason for this change lies principally in the character of the clothing of the caterpillar by which it is allied to Libytheinae. On the other hand the principal objection is the great degree of atrophy found in the front legs of the imago. But as a whole, this atrophy is inferior to that of the Satyrinae, and is not much in excess of that found in the other members of the family above the Argynnnidi. The absence of a brush of spreading hairs still further to conceal their existence should be noted. In a table which should represent the complete affinities of the different members of the Nymphalidae, the Euploeinae should not, however, occupy a low position but should be represented rather as in the accompanying scheme which, as will be seen, is but a comparatively slight modification of that proposed by Bates which we place beside it.



In a serial arrangement, moreover, such as must be employed in a systematic work, it becomes desirable to place the Euploeinae in close vicinity to the Libytheinae on account of the essential similarity of the larvae, as shown by their lack of prominent papillae bearing more or less coarse bristles or spines. By the scheme as we arrange it, the naked caterpillars are placed in immediate proximity to the Libytheinae, which are at most pilose; the groups in which the segments form one undivided or nearly undivided section, the Argynnnidi, Melitaeidi, Heliconinae, etc., are brought together; the conspicuously spiny caterpillars are all grouped in near

* "Tribu qui a été l'objet de beaucoup d'hésitations." (Bar.)

† = Danainae + Danaoid Heliconidae of Bates. Schatz has separated the "Danaoid

Heliconidae" as a distinct family to which he has given the name Neotropiden. We should rather regard them as a tribe, Ithomyidi, of the subfamily Euploeinae.

vicinity ; while those whose terminal segment is distinctly bifid, the Satyrinae, Apaturidi and Morphinae, are also brought into immediate juxtaposition. It also brings together those groups in which the segments are subdivided into a large number of sections, where the sculpture of the head is frequently reinforced by extensive processes to match the bifid caudal extremity, and where the body clothing consists never of spines but always of coarse and exceedingly abbreviated bristles, seated on papillae so numerous and large as to give the body a granulose appearance, or else, as in *Caligo*, by more or less fleshy processes, comparable to those found in the Nymphalidi. On the other hand, by placing the Euploeinae either at the head of the series or immediately above the Nymphalidi, we disturb to a considerable degree the symmetry of the serial arrangement based upon the larval clothing and the division of the segments, as well as on the brush-like character of the fore legs, while neither position would accurately represent the relative range of these groups, if based wholly upon the mere atrophy of the fore legs. In a serial arrangement, therefore, it is best to place the Euploeinae and the Heliconinae (the only essentially tropical groups among those mentioned above, which are considered in this work immediately above the Libytheinae, with the understanding that in the entire range of their characters they rank nearly as high as any Nymphalidae.

The reasons for placing the Libytheinae at the end of this family rather than at the head of the next will be discussed under that subfamily.

Table of subfamilies of Nymphalinae, based on the egg.

- Egg half as high again as broad, vertically ribbed.
 - Egg scarcely narrowing at base, the ribs but little prominent.....**Euploeinae.**
 - Egg narrowing distinctly at base, the ribs prominent.
 - Egg narrowing very much more above than below.....some **Argynni.**
 - Egg subfusiform, narrowing about equally above and below.....**Libytheinae.**
- Egg much less than half as high again as broad, usually but slightly higher than broad, ribbed, or reticulate.
 - When ribbed, the ribs at least twice as elevated above as below, sometimes wanting below ; when reticulate, heavily reticulate, the angles of reticulations filamentous.....**Nymphalinae** (excl. *Chlorippe*).
 - When ribbed, the ribs of about equal height above and below ; when reticulate, delicately reticulate or almost smooth, never filamentous.....**Satyrinae, Chlorippe.**

Table of subfamilies, based on the caterpillar at birth.

- Cuticular appendages of body few and mostly ranged.
 - Ranged appendages club-shaped or larger at some point before the tip than at a previous point. Head much larger than the thoracic segments.....**Satyrinae.**
 - Ranged appendages simple, tapering hairs, sometimes scarcely clubbed at tip. Head not much larger than thoracic segments.
 - Ranged appendages not larger than the segments (in New England species).
 - Some papillae or other prominences of the body much larger than others.
 - Eighth abdominal segment with a pair of special large papillae.....**Euploeinae.**
 - All papillae of eighth abdominal segment of usual size.....**Nymphalidi.**
 - All papillae of equal or subequal size.....**Apaturidi.**
 - Ranged appendages much larger than the segments.....most **Nymphalinae.**
 - Cuticular appendages of body numerous, not ranged, forming a short pile.....**Libytheinae.**

Table of subfamilies, based on the mature caterpillar.

- Last segment bifurcate (in all New England species).
 Head crowned by simple appendages or by none.....**Satyrinae.**
 Head crowned by a branching appendage.....**Chlorippe.**
 Last segment rounded, entire.
 Body covered with spines.....**Nymphalinae** (excl. *Chlorippe*).
 Body without spines.
 Body furnished with a few long fleshy filaments.....**Euploeinae.**
 Body covered with pile only.....**Libytheinae.**

Table of subfamilies, based on the chrysalis.

- With (generally numerous) conspicuous prominences.....**Nymphalinae.**
 Wholly unprovided with conspicuous prominences.
 Exceedingly plump and furnished with a series of minute tubercles on a transverse abdominal ridge.....**Euploeinae.**
 Of ordinary slenderness and with no transverse ridges (in New England species).
 A mediodorsal abdominal carina.
 Front of head deeply excised between ocellar tubercles.....**Chlorippe.**
 Front of head scarcely excised between ocellar tubercles.....**Libytheinae.**
 No mediodorsal abdominal carina.....**Satyrinae.**

Table of subfamilies, based on the imago.

- Some of the nervures of fore wings swollen at the base. Palpi slender, strongly compressed, heavily fringed with long scale-hairs.....**Satyrinae.**
 None of the nervures swollen. Palpi rather stout, not greatly compressed, the fringe slight, short and delicate.
 Antennae naked.....**Euploeinae.**
 Antennae clothed abundantly with scales.
 Palpi not so long as the thorax; fore-legs of both sexes atrophied and imperfect.....**Nymphalinae.**
 Palpi much longer than the thorax; fore-legs of ♂ atrophied, of ♀ normal, except in being shorter than the others.....**Libytheinae**

SUBFAMILY SATYRINAE.

SATYRS OR MEADOW BROWNS.

- | | |
|--|---|
| Satyrinae Bates; Satyri Fabr.; Satyridae Swains.; Satyrides Boisd.; Satyrites Blanch.-Brullé; Satyroidae Wall.; Satyritae Lucas; Satyrina Herr.-Schaeff.; Satyridi Staint. | Oreades Borkh.
Praetores + Dictatores Herbst.
Thysauriform stirps (pars) Horsf.
Hipparchiides Kirb.
Limaciformes (pars) Newm.
Fureulae Guen. |
| Papilionae nymphales gemmati Wien. Verz. | |

Fluttering like some vain, painted butterfly
 From glade to glade along the forest path.

ARNOLD.—*The Light of Asia.*

Imago. Butterflies of medium size. Head of moderate size; front tumid, protuberant below; antennae inserted in a common, transverse hollow, separating the front from the vertex, very slender, scaled, straight, as long as or longer than the abdomen, consisting of about 35-45 joints, the limits of the club ill-defined, occupying from one-fourth to one-half of the apex in a gradually enlarging area; palpi slender, the

clothing nearly all in a vertical plane, giving it the appearance of considerable compression.

Thorax moderately slender, compressed, upper surface greatly vaulted, especially in the middle; anterior sides of mesoscutellum slightly hollowed, forming together about a right angle; posterior curve the sometimes angulated arc of a circle a little beyond the centre of which is the apex of the piece. Metascutellum having nearly as great a superior as a posterior face, and forming a transverse piece, about twice as broad as long and as broad as the distance of the posterior angles of the metascenta apart. Metascenta moderate, protuberant in the middle below.

Fore wings produced somewhat at the apex to a well rounded angle, generally slightly full at the outer border, which is seldom angulated or even wavy; costal nervure greatly swollen at the base (in all American genera), terminating a little beyond the middle of the costal border; first and generally also the second superior branches of the subcostal nervure arising just before the apex of the cell, the other two at some distance beyond; the inferior branches are much as in the *Nymphalinae*; discoidal cell usually at least half the length of the wing, closed by distinct veins; median nervure often swollen at the base, the branches equidistant, the first arising at the middle of the cell, the last at its tip, which curves toward the subcostal nervules; submedian nervure sometimes swollen at the base; internal nervure wanting. Hind wings not greatly smaller than the fore wings, broadly rounded, generally without tails, angles, or more than slight crenulations; inner border forming a gutter for the reception of the abdomen; costal nervure terminating at about the middle of the outer half of the costal border; subcostal nervure taking its rise apparently as a dependent of the costal nervure (not so conspicuously so in *Oeneis*), its lower branch curving strongly at base toward the median; cell closed by a slender vein, connecting the lower subcostal nervule just beyond its initial curve to the last branch of the median at its curve, directed outward from the subcostal toward the median nervule; the branches of the median nervure arise further from the base of the wing than the corresponding ones of the subcostal nervure, the terminal one curving to receive the vein closing the cell; submedian nervure terminating at the anal angle; internal nervure terminating at about the middle of the inner border.*

Forelegs very small, variable in division and armature; the male tarsi consist of a single joint, sometimes divided by sutures into from three to five unarmed articulations; in the female they are divided into four or five joints, sometimes unarmed, sometimes with apical spurs and sometimes with scattered spines only. Male abdominal appendages: upper organ provided with a hook as long as or longer than the centrum and generally as long as or longer than the clasps; also, with a pair of slender, tapering, backward directed appendages on the sides; clasps pretty long and slender, at least four times as long as broad, tapering on the apical half and generally becoming very slender.

Egg. Spherical, flattened at the base, and rounded, though usually slightly flattened at the summit; the sides full and broadest below the middle, usually in the middle of the lower half; covered either with very inconspicuous cells or with very numerous, delicate, longitudinal ribs; surface minutely granulose. Micropyle composed of minute angular cells, increasing a little in size outwardly and separated by delicate raised lines.

Caterpillar at birth. Abdomen tapering very slightly and regularly from in front backward, the last segment often showing little or no sign of its subsequent bifurcation. Body furnished above, on either side, either with two rows, or with a double row, of clubbed appendages, one placed anteriorly and one posteriorly on each segment; the sides with another row, formed of a single appendage, placed centrally above the spiracles of each segment, and, beneath, another double row, its members not quite in a line—all seated on papillae.

* A very anomalous distribution of the veins margins, is shown by Wood-Mason to occur of the fore-wing, both at the costal and inner in the Indian genus, *Parantirrhæa*.

Mature caterpillar. Head well rounded, smaller than the largest part of the abdomen, although not always of a less size than the first thoracic segment, with no protuberances, excepting at the summit, which sometimes bears on either side a long, straight, conical horn. Body nearly or quite cylindrical, largest at or in advance of the middle, tapering more or less toward either end; the terminal segment longitudinally forked, each fork extending backward as a conical projection, often of considerable length. Legs and prolegs short but not very stout. Surface of the body profusely studded with papillae, each giving rise to a very short hair; ornamented with longitudinal colored bands, some of which are frequently composed of oblique dashes, one to a segment. The segments are cut by transverse incisions, usually into six sections, the front one the largest, the last incision frequently obscure.

Chrysalis. Head scarcely at all or but little produced in front; the anterior curve of the thorax very high; ocellar prominences often not at all pronounced. Abdomen broadly rounded, not deeply separated from the thorax, the lower surface of the body nearly straight, slightly and broadly curved; the whole body well rounded, with few or no tubercles excepting the slight projections at base of wings; edges of the wings very slightly raised above the level of the body and not at all thickened at the border, but generally carinate from the wing tubercle backward.

Characteristics of the group. The butterflies of this subfamily present among Nymphalidae a very distinctive appearance. Their sombre hues, almost always, and in eastern North America invariably, inclining to dark brown; their markings, mostly confined to round ocellated spots upon the under and to some extent upon the upper surface, near and parallel to the outer border (oftenest occurring in the lower subcostal and lower median interspaces); together with the delicate texture of the membrane of the wings, the suppleness of the nervures, which are usually inflated at the base (a character, however, not found in some exotic genera and shared by some genera in neighboring subfamilies); and the excessive atrophy of the fore legs in the males—all combine to separate these insects from those of any other large group.

There is no doubt that in many cases the sombre markings in this group are instances of protective resemblance, the under surface of the hind wings being marbled or mottled with darker and lighter colors, in such a way as to render the insect very difficult to see when alighted, for instance, upon a gray rock. That this is its purpose is indicated, not only by the invariable habit of insects of this subfamily to alight with closed wings, showing only their under surface, but their very common trick of immediately dropping the front wings into concealment between the hinder pair, and also of tipping over to one side and resting in a half reclining posture, the gray wing against the gray rock.

The caterpillars may be readily recognized by the peculiar bifurcation of the terminal segment of the body, shared with us only by the genus *Chlorippe*; they are almost invariably—with us, always, so far as is known—clothed only with a short but coarse pubescence arising from papillae so numerous as to give a shagreened appearance to the skin,* and

* Boisduval describes the hairs on the body of one species as bifid.

longitudinally striped with continuous or broken bands of color. Distant rightly considers this a form of protective coloring, and even looks upon the forked tail as in some measure protective, and on this type of larva as a "very primitive form." He remarks (Rhop. Mal., 37) :

Dr. Weismann has made the most profound and philosophical study of larval characters, principally as found in the Sphingidae, a family which strongly exhibits more or less specialized larval markings. He considers the oldest *Sphinx* larvae as being without markings and probably protected only by adaptive coloration and a large caudal horn, etc. It is at least probable that the bifid tails of the *Satyrinae* fulfil an analogous protective function with this caudal horn in the Sphingidae. . . With the next stage of Sphingid evolution, where the larvae have become longitudinally striped, we may almost apply Dr. Weismann's very words to the *Satyrinae*. — "The caterpillars thus marked must have been best hidden on those plants in which an arrangement of parallel linear parts predominated; and we may venture to suppose that at this period most of the larvae of the Sphingidae lived on or among such plants (grasses)."

The caterpillars eat slowly and are very long in attaining maturity; and as the egg and chrysalis states are usually longer than common, the species of this group are almost without exception single brooded, and, in the genus *Oeneis*, some species are supposed to take two years to complete the cycle of growth. So far as known, the larvae feed only on grasses and sedges.* It is probable that the larvae of nearly all the species hibernate; this is known or presumed to be the case in all our own species. M. Marloy who seems to have been more successful in finding the caterpillars of the European species than any one else, obtained them all in the months of March, April and May.†

In this subfamily are found some curious and instructive exceptions to the general rule of pupation among the Nymphalidae, a family, which, as is well known, suspend themselves by the hinder extremity during the chrysalis state. In certain European species, whose transformations were first studied by M. Marloy, the caterpillar goes beneath the ground to pupate and forming a large oval cocoon or cell, composed of grains of earth connected by a little silk, undergoes its transformations therein without suspending or attaching itself in any way whatever. In one of our species of *Oeneis*, as will be seen further on, we have an even more extreme case. In another European species, *Melanargia galathea*, as Mr. H. W. Bates informs me, Messrs. Hellins and Buckler have found the chrysalis lying on the ground between stems of grass, the shrivelled skin of the larva remaining attached to the hinder extremity of the chrysalis. Both Boisduval and Duponchel give a similar account of it, but Hübner represents it as suspended. Mr. Edwards has recently bred the

* The only exception known to me is the European *Coenonympha tiphon*, the caterpillar of which is said by Merrin to feed on *Rhynchospora*, one of the Cyperaceae.

† Ann. Soc. ent. Fr. vii, 263-7 (1838). Pritt-

witz also states (Stett. ent. zeit., xxii) that all European species, except two, probably or certainly winter in the larval stage, and these exceptional insects, curiously enough, are almost the only ones which are double-brooded.

species in this country from specimens sent over and had an experience similar to that of Messrs. Hellins and Buckler, of which he will doubtless soon publish the details. But besides this insect, we now know of at least eight European species, mostly referred to *Satyrus* but some to *Epinephele* and *Pararge* as well, the chrysalids of which are not suspended; and so far as yet appears these all belong to the section of *Satyrinae* which have vertically ribbed eggs. Most of the species, however, whose transformations are known, suspend themselves after the manner of other *Nymphalidae*.

The butterflies may be further distinguished by their peculiar flight, which is of a feeble, wavering, dancing character and not long sustained; neither do the insects rise far above the ground.* Wallace, in writing of the species found on the Amazons, says he does not "remember to have ever seen any species rise four feet from the earth, while the greater number of them do not exceed as many inches" (*Trans. Ent. soc. Lond.*, (2) ii: 261). They are shade-loving insects. "They chiefly affect the glades and lanes of the woods, being not often seen in the clearing; sometimes however they come into our gardens of a morning, but then they fly along close to the ground, beneath the shrubs and in the shelter of the fence, as if shade were more congenial than sunshine. Perhaps as there is a correspondence and a harmony in all the divine works, there may be a reference to these retiring habits in the dull tints common to the tribe and the want of those glowing colors so general among butterflies (*Gosse, Alab.*, 55-56). Some genera of the allied *Morphinae*, found in S. America, are said by Wallace (*loc. cit.*) to be "truly crepuscular, never flying by day except when disturbed, but appearing to be voluntarily active only for about half an hour before sunrise and after sunset; they remain hid during the day in the gloomiest shades of the forest." Thwaites also, speaking of the subtropical *Satyrinae*, says (*Moore, Lep. Ceylon*, i:13) that "their movements are more lively in the early morning and evening during their amatory gambols"; and Nicéville remarks (*Butt. India*, i:104) that the hundred or more species of *Mycalesis* "seldom take flight unless disturbed, except toward evening."

In certain features the *Satyrinae* show some curious resemblances to the *Hesperidae*, a group the farthest possible removed from it among butterflies. The eggs of the ribbed species closely resemble those of the *Hesperidi* in general appearance; the caterpillar at birth has a similarly large and striking head, and occasionally the terminal segments of the body are armed with much longer cuticular appendages than elsewhere, a common feature among the *Pamphilidi*; the mature caterpillar is sluggish

* Mr. Trimen says he has "noticed that those species which do not possess the basal inflation of the nervures of the forewings pos-

sess greater powers of flight and a more robust structure generally." *Rhop. Afr. Austr.* 185.

in motion, with a somewhat flattened belly and short prolegs, giving a limaciform body, which is clothed with pile only; the chrysalis is unusually rounded and occasionally is not suspended, and the imago often has an oblique patch of raised hairs or scales on the upper surface of the forewings concealing the androconia, which remind one strongly of the similar stigma one often finds in the Pamphilidi. That these peculiarities have some phyletic meaning it is impossible to doubt, but they should not be allowed to overshadow or in any way to conceal the great body of characteristics by which this group forms a part of the great and varied family Nymphalidae.

Allusion has just been made to the androconia or male scales occurring sometimes in this subfamily; with the exception of the Euploeinae and the Argynnidi this is the only group of Nymphalidae in which they are frequently present; and so far as known they possess here the uniform character of exceedingly attenuated scales with a tasselled tip. They by no means occur in all genera, and sometimes show no external sign of their presence; they are generally found upon the upper surface of the front wings, and often in the form of an oblique stigma. In some Asiatic species, according to Thwaites (Moore, Lep. Ceylon, i: 13) they are present as "a pair of curious pencils of hair which each lie within a fold of the upper wing, and which are capable of being spread out radiately during the insect's flight." I am not aware that any odor has been detected in any of them; I have been able to detect none in our two species of *Oeneis*. About half of our species possess no androconia.

Some instructive memoranda are furnished by Mr. Edwards upon the characteristics of the early stages of our Satyrids in the Canadian entomologist, xv: 68, based on his extensive knowledge through breeding. The facts there brought forward show that the arrangement of the genera commonly adopted in Europe is altogether unnatural, as one would expect to find it, founded solely upon a few characters drawn from the neuration of the wings; an excellent opportunity for inaugurating a new and more substantial classification is now open to the general student.

Little is known of the enemies of the Satyrinae. The sluggish habits of the caterpillar must subject them to hymenopterous attacks, against which they have only their nocturnal life to guard them, for nearly without exception, they feed exclusively by night. The caterpillars of the genus *Oeneis* with their peculiar habitats are known to be specially subject to such insect foes. The butterflies with their gentle flight, almost always in or near shrubbery, are also specially subject, one would think, to attack by birds. And Gentry tells us that he has often found them in the stomachs of such birds as the night hawk (*Chordeiles virginianus*), the Acadian flycatcher (*Empidonax acadicus*), the wood pewee (*Contopus virens*), and the scarlet tanager (*Pirangra rubra*).

Geographical distribution. This subfamily is more widely spread over the globe than any other similar group of butterflies, being universally present wherever butterflies occur. Though, with the allied *Morphinae* (which perhaps should not be separated from them even with a subfamily valuation), it is represented in the tropics of America by some of the largest and most brilliant of its class, its members extend to polar colds and alpine summits, and embrace several genera peculiar to such regions. Yet wherever they occur the *Satyrinae* can be recognized by their peculiar facies, and have nowhere lost their characteristic flight and habits.

Not only in New England, but in the whole of eastern North America they are very poorly represented; indeed only about half a dozen species are found in the larger region which do not occur in New England, and they form, in either case, but a mere fragment of the butterfly fauna; in western North America they are a little more abundant, but even there bear no such relation to the general fauna as they do in Europe, where they compose nearly one-third of the whole fauna and are relatively more than four times as numerous as in New England. It should be further noted that the bulk of the European fauna belongs to the first section of the family as divided in this work; while in eastern North America the larger number belongs to the second section. Moreover two of the eastern genera belonging to the first section, the only two represented in New England by more than a single species, are either common to New England and Europe on the one side and the Pacific slope of America on the other, or are represented by very closely allied genera; so far as known, the other genera (of the second section) do not occur in the western part of America, but are more nearly allied to subtropical forms;—with one exception, *Satyrodes*, which seems somewhat unique.

Two out of the sixteen recognizable fossil remains of butterflies belong to this subfamily, and both of these come from the same beds in the south of France; both, too, though belonging to different genera, are much more closely allied to existing Indian forms than to any now living in Europe—a fact which excites more interest from the great abundance and variety of these insects in the Europe of to-day. One of these fossils indeed, *Lethites reynesii*, is more nearly allied to one of our New England species, *Enodia portlandia*, than to any of the living European *Satyrinae*.

Table of genera of Satyrinae, based on the egg.

Surface distinctly furnished with vertical ribs.

Ribs stout, thickened at intervals, more or less irregular.....*Oeneis*.

Ribs delicate, nearly uniform and regular.....*Cercyonis*.

Surface not vertically ribbed.

Reticulation inconspicuous; egg distinctly broader than high.

Surface completely smooth.....*Enodia*.

Surface faintly and very delicately reticulate.....*Satyrodes*.

Reticulation not inconspicuous; egg almost globular.

Cells of reticulation as large on the lower as on the upper half of egg....*Neonympha*.

Cells of reticulation larger on upper than on lower half of egg.....*Cissia*

Table of genera, based on the caterpillar at birth.

- Summit of head regularly rounded, without tubercles; appendages of body strongly bent.
 Appendages of the body very short, not one-half the length of the segments. **Oeneis.**
 Appendages of body long, much longer than the segments. **Cercyonis.**
 Each side of head surmounted by a rounded tubercle; appendages of body straight.
 Appendages of anterior half of body short, not one-third the length of the segments.
 Appendages of a few terminal segments no longer than the segments. **Satyrodes.**
 Appendages of a few terminal segments twice as long as the segments. **Neonympha.**
 Appendages of anterior half of the body long, nearly or quite as long as the segments.
 Head with slight conical coronal tubercles. **Enodia.**
 Head with prominent globular coronal tubercles. **Cissia.**

Table of genera, based on the mature caterpillar.

- Body stout, not greatly constricted behind the entire head.
 Body longitudinally and conspicuously striped with broken bands; width of head about half the greatest width of the body. **Oeneis.**
 Body longitudinally and inconspicuously striped with continuous bands; head nearly as broad as greatest width of body. **Cercyonis.**
 Body slender, tapering forward to form a distinctly constricted neck; head crowned with summit tubercles.
 Summit tubercles of head large, conical, tapering, nearly as high as rest of head.
 Head stout and, including tubercles, half as high again as broad. **Enodia.**
 Head slender and, including tubercles, twice as high as broad. **Satyrodes.**
 Summit tubercles of head slight and inconspicuous (in New England species).
 Larger papillae of head distant and scattered. **Neonympha.**
 Larger papillae of head closely crowded together. **Cissia.**

Table of genera, based on the chrysalis.

- Thorax regularly rounded; head not prominent, its anterior and inferior surfaces not forming less than a right angle.
 Cremaster abbreviated, without hooklets. **Oeneis.**
 Cremaster normal. **Cercyonis.**
 Thorax regularly rounded; head thrust forward, its anterior and inferior surfaces forming less than a right angle.
 Abdomen destitute of longitudinal carinae.
 Front of head entire between the ocellar tubercles.
 Abdomen tapering rapidly, beyond the wing cases much shorter than they. **Enodia.**
 Abdomen tapering gradually, beyond the wing cases as long as they. **Satyrodes.**
 Front of head distinctly emarginate between the ocellar tubercles. **Neonympha.**
 Abdomen with a pair of distinct longitudinal carinae. **Cissia.**

Table of genera, based on the imago.

- Antennae gradually incrassated on the apical third or fourth.
 Eyes naked. **Cercyonis.**
 Eyes pilose.
 Spines of middle tibiae infrequent; antennae composed of more than forty joints. **Enodia.**
 Spines of middle tibiae very numerous; antennae composed of less than thirty-six joints. **Satyrodes.**
 Antennae gradually incrassated from just beyond the middle.
 Costal nervure of fore wings scarcely tumid at the base; hind wings considerably elongated. **Oeneis.**
 Costal nervure of fore wings very tumid at the base; hind wings well rounded.
 Antennae composed of less than forty joints; outer border of hind wings more rounded than in fore wings. **Neonympha.**
 Antennae composed of more than forty joints; outer border of fore and hind wings similarly rounded. **Cissia.**

SECTION I.

Egg vertically ribbed and cross-lined. *Caterpillar at birth* with bent cuticular appendages and a head uniformly rounded above. *Mature caterpillar* comparatively stout, with a head not much or not at all larger than the segments behind it, and with no summit tubercles. *Chrysalis* with a regularly rounded mesonotum and the head not prominent. *Imago* with lower extremity of cell of fore wing strongly extended outward; base of middle median nervule of hind wing scarcely if at all nearer the outer than the inner nervule.

GENERA: *Oeneis*, *Cercyonis*.

OENEIS HÜBNER.

Oeneis Hübn., Syst. verz. bek. schmett., 58 (1816).

Chionobas Boisd., Icon. hist. Léop. Eur., 182 (1832).

Type,—*Papilio norna* Esper.

We are tougher, brother,
Than you can put us to't.

SHAKESPEARE.—*Winter's Tale*.

In lonely wastes,
When next the sunshine makes them beautiful,
Gay troops of butterflies shall light to drink
At the replenished hollows of the rock.

BRYANT.—*A Rain Dream*.

Imago (52:6). Head small, tufted with longer and shorter, pretty equally distributed hairs; front full, curving on every side, protuberant in the middle below, narrower than the eye, perhaps broader than high, terminating rather squarely above at the anterior base of the antennae; lower edge rather abrupt, pretty well rounded; vertex very short, transverse, somewhat protuberant, the posterior edge slightly convex, the anterior concave at the sides, convex in the middle; flanks moderately full; upper border of the eye scarcely angulated opposite the anterior edge of the vertex. Eyes of moderate size, pretty full, naked. Antennae inserted slightly in advance of the middle of the head, in a deep, broad pit disconnecting the front and vertex, the interior bases of the antennae meeting each other; composed of from thirty-seven to thirty-nine joints; considerably longer than the abdomen, very gradually and constantly increasing in size from about the middle, so as to make it difficult to mark any portion as the club; the last four joints diminish slightly in size, terminating in an abrupt cone; the apical half is cylindrical, scarcely depressed and minutely carinate along the under surface. Palpi slender, about twice as long as the eye, the apical joint one-fourth as long as the middle joint; profusely clothed beneath with long, above with short hairs, all placed in a vertical plane, excepting a few near the base, which tend in a lateral direction.

Prothoracic lobes very small, wedge-shaped, narrowing downwards, twice as broad as high, and upon the summit less than half as long as high, of the same height and of the same length throughout, excepting that the lateral ends are well rounded off. Patagia not very large, but little convex, the posterior scarcely longer than the descending lobe; both broad and pretty broadly rounded.

Fore wings (38:5) somewhat produced at the apex and abbreviated at the lower outer angle; costal border a little convex at base and tip, but between them nearly straight; outer border but slightly convex above the middle median nervule; below that receding strongly; inner border straight. Costal nervule not very much swollen, diminishing

very regularly and gradually in fulness, terminating a little beyond the apex of the cell; subcostal nervure with its second superior branch originating between the base of the first branch and the apex of the cell; the discoidal cell three-fifths the length of the wing and rather more than three times as long as broad; median and submedian nervures not enlarged at the base. Hind wings unusually long, in particular produced in the subcostal region; costal border very gently convex next the base, straight beyond until near the tip; outer border strongly but not regularly convex; inner border a little and pretty regularly convex. Subcostal nervure following for a short distance the lower margin of the costal nervure; the veinlet closing the cell striking the median nervure beyond its last divarication and the subcostal nervure as far beyond its last divarication as the greatest width of the cell; the branches of the median nervure originate scarcely further from the base than the corresponding branches of the subcostal nervure. The whole under surface of both wings is furnished with hairs as well as scales.

Androconia very slender and elongated, broadest at the extreme, rounded base, tapering to beyond the middle and terminating in a thread emitting lateral threadlets, apically expanded and as long as the extreme width of the lamina. The androconia occur only on the upper surface of the front wings.

All the legs very hairy. Fore legs minute, cylindrical, the tibiae about one-fourth the length of the hind tibiae; tarsi scarcely longer than the tibiae, consisting in the female of five joints, of which the first occupies the basal half, the second, third and fourth are equal and the fifth a mere minute conical projection; in the male the second to fourth joints coalesce; leg wholly unarmed in the male excepting by the long concealing hairs, which do not expand laterally; but in the female both tibia and tarsi are supplied with a few very minute and very slender spines scattered irregularly over the upper surface, but mostly on the sides and never at the tip of the joints. Middle tibiae four-fifths the length of the hind tibiae; tibiae furnished on either side of the under surface with a row of forward and slightly outward directed short spines, terminating at the apex in a longer spur; upper surface with a few very short scattered spines; first joint of tarsi fully equal to the three succeeding together, which are about equal but decrease in length successively, the fifth as long as the second; all furnished with a row of short, forward directed spines on either side of the under surface; between the rows many others, varying in length and irregularly placed; claws well curved throughout, pretty slender, rather bluntly pointed; pulvillus small, longer than broad, of nearly equal breadth; paronychial forming on each side of the foot a slender, delicately tapering and pointed ribbon, shorter than the claw.

Upper organ of the abdominal appendages stout, but slightly curved, rapidly narrowing at the base of the hook; the latter strongly and equally compressed, a little curved, as long as the centrum, bluntly pointed at the tip; sides of the centrum bearing, near the base of the hook, a single slender, tapering, compressed, slightly arcuate, backward directed appendage, fully half as long as the hook; clasps rather stont, bullate, of about the length of the upper organ on the basal half, about one-third as broad as the entire length, beyond the middle rapidly narrowing, so that the apical third is only about half as broad as the base, upper edge nearly straight, tip broadly rounded or truncate; whole blade regularly and considerably arcuate, whether viewed from above or from behind; terminal third of the upper edge denticulate.

Egg. Spherico-ovate, rather higher than broad, broadly rounded beneath, above somewhat flattened but also well rounded, largest at about the middle of the lowest three-fifths, narrower above than below; sides, from very near the base to the micropyle, furnished with a large number of low and broad, rounded, sometimes apically pinched, irregular ribs, often zigzag in course, not always extending the whole length, often combining in different parts of the egg, and often presenting a more or less beaded appearance from the transverse wrinkles or slight lines which traverse the egg transversely; next the base the ribs sometimes fade away into pretty large granular elevations, and upon the summit they become much smaller and more irregular, often having a somewhat spiral direction as they approach the micropyle. The latter is

composed centrally of six or eight radiating cells, together forming a circle, and surrounded by pretty large cells, those next the circle pretty regular, the outer ones larger, their shorter axes turned toward the centre.

Caterpillar at birth. Head considerably broader than the body,* appressed speroidal and uniformly curved, furnished with two transverse curving rows of distant papillae across the upper half of the face and a few below, each bearing a short club-shaped hair. Body tapering very regularly from in front backward, the last segment being about half as broad as the first and distinctly forked, but in a different manner with each species, furnished throughout with minute, curved, club-shaped hairs seated on distant ranged papillae, viz.: on the thoracic segments in laterodorsal, lateral and suprastigmatal series, one to a segment centrally placed; and a pair of infrastigmatal papillae; on the abdominal segments, a subdorsal series, anteriorly placed; a supra-lateral slightly posterior; a suprastigmatal slightly anterior, all one to a segment; and a pair of infrastigmatal papillae. The body bears straight longitudinal stripes of varying widths.

Mature caterpillar. Head small, very regularly rounded on all parts, the upper half slightly appressed or not quite so thick as the lower portion, slightly the broadest next the upper edge of the ocellar field, slightly broader than high, the halves scarcely separated by a perceptible notch above, rather full in the lower outer region; triangle reaching rather more than half way up the head, the base a little concave, twice as high as broad, the sides a little sinuous, rapidly tapering at the summit, depressed in a groove but little distant from and subparallel to the suture at the sides; whole head profusely covered with minute rounded papillae, each giving rise to a very short, not very delicate, hair, and alternating with pretty deep rounded punctulations; first joint of antennae mammiform, second exceedingly short, third twice as long as broad, cylindrical, squarely docked; ocelli, five in number, four forming an open curve, its convexity forward, one being placed midway between the uppermost and lowermost and the remaining one crowded between the first and third, counting from above; the fifth is placed directly behind the fourth, which is as far from it as from the second; the third larger than the others, which are equal; labrum scarcely twice as broad as long, its angles rounded, excised in the middle of the front; mandibles very small but stout, edges smooth; maxillary palpi with each successive joint smaller than the previous.

Body plump, cylindrical, thickest at the first two abdominal segments, narrowing gradually behind, a little more rapidly, although still very gently, in front; terminal segment of equal breadth and length, conical, but truncate, the apex strongly excised at the extremity of a deep medio-dorsal furrow above, the apices of the two halves having the appearance of pretty large rounded tubercles; body profusely and uniformly covered with irregularly distributed, minute, low, conical papillae, each giving rise to a very short, equal, not very delicate hair; spiracles obovate, fully twice as high as broad; legs rather stout, short, conical, especially the last joint; claw rather small and slender, scarcely compressed, somewhat curved; prolegs short, quite stout.

Chrysalis. Short, stout and high, with scarcely any prominences; anteriorly very high and abrupt, scarcely depressed on the summit of the thorax, the anterior curve forming nearly a right angle with the lower anterior surface; very slightly hollowed between the thorax and abdomen and well rounded at the tip, which is nearly as low as the under surface; viewed from above the anterior curve is broadly rounded, rather abruptly shouldered at the basal wing tubercle; beyond that parallel and nearly straight to the middle of the abdomen, when the body tapers with a broad curve, the cremaster projecting but slightly beyond it; the angle between the front and summit of the head rounded off; the ocellar prominences very little pronounced; basal wing tubercle rather large, very low, irregular and blunt, transversely pinched a little; thorax with a dorsal line, slightly elevated on the pronotum, slightly impressed on the

* Sandberg describes the head of the young body, which I think cannot be the case with *Oeneis bore* as small in proportion to the any *Oeneis* at birth.

mesonotum, and raised more distinctly on the metanotum; cremaster very short and inconspicuous, without hooklets. Body rather delicately corrugated with frequent, tremulous, slightly impressed, transverse lines.

This is one of the most interesting genera in the whole butterfly world, appearing only in alpine and arctic or subarctic regions: inhospitable regions, where snow lies upon the ground by far the greater portion of the year; or, as Boisduval remarks,—They are born where nature expires! Yet the genus is richly endowed with species; until recently they were best known in the highest latitudes, from the northernmost parts of Europe and all but the southernmost parts of Labrador; one species has been long known as peculiar to the Alps of central Europe, and another to our own White Mountains; ours is, however, but distantly related to the alpine species, much more closely to another (*O. oeno*) common to the arctic regions of the old and new worlds. Of late years the number of recorded species has considerably increased, especially from among the Rocky Mountains of our own country; one species also occurs in the Himalayas and two others are described from the Andes of Chili, but it is asserted, and not improbably with justice, that the latter belong to a distinct genus. Within the region embraced in this work, two species occur; one is confined to the White Mountains of New Hampshire and the Rocky Mountains of Colorado; the other belongs to subarctic regions of both worlds but occurs in one locality in New England.

The *Oeneides* are sombre hued insects, rather more sparsely scaled but more hairy than their allies, of nearly uniform brownish and ochraceous tints above, sometimes marked with darker ocellate spots in the outer half of the wings, especially upon the under surface; beneath they are more or less marbled with ashy tints, particularly on the hind wings, which have a not very conspicuous but very broad, darker, irregular band across the middle. The cell of the wings, as well as the wings themselves, are of unusual length; other structural peculiarities are the very gradual development of the club of the antennae, which increases almost insensibly in size from about the middle of the antenna, and the hairiness of the legs (to which Westwood calls attention) and of the under surface of the wings, as if for much needed warmth.

As far as known the species are at most single brooded, and in several cases it is presumed that two years are necessary for the complete cycle. The earliest stages—egg and caterpillar at birth—are known of half a dozen species, but the later stages of the caterpillar and of the pupa of only one or two. Our own White Mountain species is the best known. That of *O. bore* has been described by Sandberg, who says that the larva is very indolent, and when handled shrinks and remains long motionless, which is equally true of *O. semidea*. *O. bore* hibernates twice as caterpillar and changes to chrysalis in May in the winter quarters of the larva, free, in

sand, between roots of grass under the surface of the ground, appearing on the wing in June. The history of *O. semidea* is probably similar; but *O. jutta* requires only one year for its changes, hibernating as a full grown caterpillar. The egg of *Oeneis* is provided with numerous coarse and wavy longitudinal ribs, and this stage lasts from ten to twenty days. The caterpillar at birth has a large head and a regularly and considerably tapering body with rather brightly colored longitudinal stripes; sometimes at least it hibernates in this condition. The mature larva feeds on sedges and grasses, and perhaps on *Juncus*, has a smooth, rounded and banded head, the last segment of the body moderately and bluntly forked, and the sides and back regularly ornamented with longitudinal series of short oblique stripes; its transformations take place under ground, and no silk or scarcely more than a thread or two is used in pupation. The chrysalis is stout, smooth, without prominences, and the cremaster destitute of hooklets; in the case of *O. bore* it lasts from three to six weeks, in *O. semidea* probably about the same.

EXCURSUS I—THE WHITE MOUNTAINS OF NEW HAMPSHIRE, AS A HOME FOR BUTTERFLIES.

On the path, straight out of the rock side,
 Wherever could thrust
 Some burnt sprig of bold hardy rock-flower
 Its yellow face up,
 For the prize were great butterflies fighting,
 Some five for one cup.
 BROWNING.—*The Englishman in Italy.*

THERE is no spot in New England where an aurelian can obtain such successful results in a brief time as in the high valleys of the White Mountain region. Not only are many butterflies which elsewhere are rare, or abundant only in very restricted localities, to be obtained here, but they occur in the greatest profusion, more than making amends for the less favorable weather which is apt to interfere with collecting in mountainous localities. From the latter part of May until late in September one is always rewarded for a few days' collecting.

Perhaps it is because my visits have mainly been to that spot that I have found the "Glen" the most favorable region. Here, in a valley running north and south, at an elevation of about 2,000 feet, following in one direction the valley of the Peabody, and in the other that of the Ellis, in a densely wooded region with high mountains on either side sloping down to the narrow valley, with considerable clearings in the river bottom, where cultivated patches, pastures, swampy tracts, hillsides overgrown with shrubbery, and damp and shaded forest roads are to be met with, nearly all the conditions for abundant insect-life are to be found at their

best. More than this, a wagon road, eight miles in length, winding half way through the primeval forest, where it forms a broad lane which the butterflies covet, half-way over the rough ledges and sedgy plateaus of the treeless upper region of our highest mountain, where flowers are blooming all through the season to captivate the tired traveller, — this road affords a ready means of learning at what altitude the valley species ascend, and what kinds inhabit the inhospitable higher levels of the mountains.

Let us speak first of those which belong in the valleys, where the vegetation is so profuse and diversified; and restrict our remarks principally to those which are commonest here, and met with more rarely elsewhere, — those which have, so far as New England is concerned, their maximum development in this district.

It is the region *par excellence* of that striking butterfly, *Basilarchia arthemis*. When the stage, with its city freight, winding its way over the hilly roads with the first rush of travel, leaves most of the farms behind it and enters the heart of the forest, flock after flock of these showy butterflies arise from the damp spots in the road where, sometimes by hundreds, they are assembled to suck the moisture from the earth, and then flutter about the stage in fascinating bewilderment, settling again to the feast in a hesitating way as soon as the disturbance is past. Indeed they sometimes become a very nuisance, dozens of them when seeking a shelter entering the open doors and windows of the farm-houses, and fluttering about the windows in a vain and distracting attempt to escape when there is any movement within.

In the early season, when the buds are just beginning to burst, the young caterpillar may be found emerging from its hibernaculum deftly fastened near the tips of black-birch sprigs everywhere growing by the roadside; in July, the bristling globular egg attached to the extreme tip of the pointed leaf of the same, and later the leaves eaten in peculiar fashion, reveal where to look for the grotesque party-colored caterpillar, scarcely to be distinguished from that of its congener, *B. archippus*. The latter is also common (though less common than in southern New England), prefers the willow and the poplar, and may be found feeding even up to the extreme limit of forest vegetation on the mountain side.

This, too, is the New England metropolis for that high-spirited butterfly, *Polygonia faunus*. Unlike *arthemis*, it is never found in flocks, but only by threes and fours at most, keeping up a constant warfare with one another; but it is still so common along the roads, and particularly in the more open spots, or where the roads enter bits of forest or cross a mountain brook, that, notwithstanding its wary activity, one may even capture in favorable times a hundred in a day; once I must have seen five hundred in a single railway ride of six miles in the forest on the western side of Mt. Washington between Fabyan's and the base of the mountain. Its cater-

pillar—also party-colored, but bristling with spines—may be found both on the black birches and the willows. Where both these plants are found in such abundance, search would seem to be vain, but if it is confined to such sprays of the smaller plants as project forward toward the road—such spots indeed as the butterflies select to alight upon—the patient search will be rewarded. Another *Polygonia*, far rarer, *P. gracilis*, I had until 1887 taken only here and on the opposite side of Mt. Washington, perhaps a couple of dozen in all in as many years: and it is almost its only known locality in New England, though it doubtless occurs in many other elevated regions favorable for *P. faunus*. In 1887 it was tolerably common, and was found to occupy a distinctly lower zone, below 2500 feet. *P. progne* is also common, belongs properly to the same zone, and I have taken its larva here on the wild gooseberry. *Engonia j.-album* is another butterfly common in certain seasons at least, and I should consider this its favorite New England ground, were it not that one night it flew by hundreds into Sankaty lighthouse on Nantucket, where in several summers' residence on the island I never saw it at any other time. *Euvanessa antiopa* is also common enough at the White Mountains, but not much more so than elsewhere. One may generally see a dozen on a good day in early June,—seedy-looking individuals which have survived the winter. *Aglais milberti* is also common in the lower country, feeding in swarms upon the nettles; and this concludes the series of *Nymphalidi* which need be mentioned.

Argynnis atlantis occurs here in the utmost profusion, as nowhere else in New England. One may easily take hundreds in a single day, the sandalwood-scented males largely predominating. *Brenthis myrina* and *B. bellona* are abundant in the restricted meadow-lands, and in about equal numbers, though *B. myrina* is far more common in central New England. But the region is one of the best for most of our *Melitaeidi*. *Phyciodes batesii* occurs here early in June, and this is its only known New England locality. *P. tharos* swarms (as it also does elsewhere) and here is the best place to search for those very local species, *Cinclidia harrisii* and *Euphydryas phaeton*. They can best be obtained in the larval state, for they may always be taken in large numbers very early in the spring in such conveniently accessible spots as the immediate borders of the Glen road, *harrisii* feeding in large companies on *Diplopappus* and *phaeton* scarcely more dispersed on *Lonicera*.

I have never paid special attention to the *Theclidi* in this region, nor had them force themselves on my notice; so that I am inclined to think none of them particularly abundant, or more so than elsewhere. Nor are any of the *Lycaenidi* exceptionally common, excepting *Cyaniris*, which is certainly far commoner—especially *C. pseudargiolus lucia*—than anywhere else in New England, abundant as it often is. The roads seem at times blue with them, and they swarm at all moist spots, occurring also to the

very edge of the forest line, and enchanting the early pedestrian at every step. They are also one of the earliest risers, and are the first to be seen when the clouds break after a rain. Of the *Chrysophanidi*, *Heodes hypophlaeas* is of course abundant, as everywhere, and *Feniseca tarquinius* may always be found in its time at the proper places; there is one isolated copse, with alder (everywhere growing in profusion), just north of the Glen House, where I never fail to see it fluttering about when in season.

Among the *Pierinae*, *Eurymus philodice* and *Pieris rapae* are of course abundant enough. I shall be surprised if *E. interior* does not some day turn up here, having escaped the net only because no one takes so common an insect as its congener, which it resembles too much on the wing to be readily distinguished from it. The only interesting form of this group found here is *Pieris oleracea*. Though nowhere nearly so common as thirty years ago, when I first collected at the mountains, when one might see fifty at a time in an open field, it is not yet quite exterminated by the invading *P. rapae*, and in the very first of the season, when a dozen or so may be taken in a day, is as common as that species; but with the advanced season it appears quite lost among the swarms of the latter. Probably it will always hold out in this, its New England stronghold.

None of the swallow-tails are pre-eminently abundant, with the single exception of *Jasoniades glaucus*. But this is indeed an exception. Early in June of any year one may take a dozen or twenty with a single sweep of the net at moist places by the roadside, or if cautious enough pick up with the fingers one specimen after another till he wearies of the task. It never fails to be abundant, and its great size and social habits make it appear the commonest butterfly of the region. The males appear to vastly outnumber the females.

The skippers may be dismissed with a few words, as most of them may be found equally abundant elsewhere; but this is certainly the best place I know for obtaining *Thanaos icelus*, and is probably the best for securing those rarer forms, *Pamphila mandan*, and *Amblyscirtes samoset*, though they are never very abundant, while *A. vialis* is always to be met with early in June.

These are the more interesting of the valley butterflies of the White Mountains, found in much greater abundance than elsewhere; but they form a small part of those which abound here, and the real interest centers in noting to what height any of them may be found. For this the open heads of the great ravines which seem to gnaw at the very vitals of the great mountain masses, with the wagon road up Mt. Washington on one side, and the broad railway-cutting at the other, forming as they do highways for butterfly as well as man, are the most interesting and instructive spots. Prominent among those which may be found, and which probably or certainly pass their lives in any part of the forest region, however

elevated, where there are open spaces, are *Basilarchia archippus*, already mentioned in this way, the *Polygonias*, *Eugonia j.-album* and *Cyaniris pseudargiolus*. Not infrequently, these fly even far above these natural limits, and have been taken or seen upon the highest points. Indeed many insects are the veriest Appalachians, seeming to take a delight in exploring the summits. This is truer of some other insects than of butterflies, and perhaps they are borne upward by the wind-currents; for in the first week of June I have found the great snow-patches at the very summit of Mt. Washington fairly peppered with numerous small insects, especially *Coleoptera*, *Diptera*, *Hymenoptera* and *Homoptera*, prominent among which were thousands upon thousands of delicate-winged plant-lice. Besides these among the larger insects an *Acanthosoma*, perhaps *A. nebulosa*, swarmed on the hotel piazza, and every pool of water by the roadside was the grave of countless *Bibio femoratus*. Of the butterflies alone which I have found upon the very highest summits are (besides two species immediately to be mentioned, characteristic of the mountain top) the following: *Basilarchia archippus*, *B. arthemis*, *Polygonia interrogationis*, *P. faunus*, *P. gracilis*, *Eugonia j.-album*, *Eu Vanessa antiopa*, *Aglais milberti*, *Argynnis atlantis*, *Brenthis myrina*, *B. bellona*, *Phyciodes tharos*, *Ine salia nippon*, *Cyaniris pseudargiolus*, *Pieris rapae*, *Jasoniades glaucus*, *Thanaos icelus*, and *Limochores taumas*,—in all, twenty species.

It will require still a good deal of field-work to determine how far up the mountain side these forms habitually breed; for, as given, the list is merely that of stragglers of an inquisitive turn of mind.

It is far more interesting, perhaps the most interesting point in the geographical distribution of New England butterflies, to find that there are two butterflies living exclusively on these inclement mountain heights. One of them, *Oeneis semideia*, is known elsewhere only on the summits of the highest peaks of the Rocky Mountains in Colorado, where it does not appear, apparently, below an elevation of about 12,000 feet, above which, and up to 14,000 feet, it has been taken on Mt. Lincoln, Sierra Blanca, the Argentine Pass, Pike's Peak, and Twin Lakes. It is, however, regarded by some as only a variety of a species found farther north; but whether variety or species, it has characteristics which separate it from the North Labrador type, while the Colorado and New Hampshire forms are inseparable. It is therefore either a distinct species or well on the road to it; and so far as its interest in this connection goes, it matters little in which light it be viewed. The other species, *Brenthis montinus*, will, in my judgment, certainly be found beyond the great range of the White Mountains, whence only it is so far known. I should look for it confidently above the forest line in the Adirondacks, in the Green Mountains, and on Ktaadn, as well as other elevated and barren heights. It has been reported as seen on Black Mountain near Thornton, N.H., which is wooded

to the summit; but an actual capture would be necessary to establish such a fact. It, too, is regarded by some as merely a variety of another species found farther north, and this northern species occurs as near as southern Labrador and Anticosti, and ranges across the country to Great Slave Lake. It is, however, separable from it, and whether to be looked on as a distinct species or merely as a variety is a pure matter of individual idiosyncrasy. The question is similar to the preceding, but at present receives no side-light from the west.

One will hardly fail to notice that while the forest line at the White Mountains is tolerably well marked (at a height of about 4,000 or 4,500 feet), it is always succeeded above by a considerable area, where the dwarfed spruce or "scrub," struggling upward with ever diminishing height, conceals the gray rocks in a covering of uniform green, excepting on the unstable surfaces of the steeper slopes,—an area which is strongly contrasted with the barren gray broken rocks above, which lie piled in vast heaps exposed to full view, except where a patch of sedge furnishes a small and barren pasture upon some more favored plateau. The sides of these mountains, where they rise to their highest culmination, are thus divisible into a forest and an alpine region, and the latter into a lower, or scrub, and an upper, or rocky, district; these two subdivisions of the alpine region correspond fairly well with the areas occupied by the two mountain butterflies just mentioned, and I have attempted to represent these areas upon the accompanying map by the two shades of brown,—the darker brown representing the region where *Oeneis* has its proper home, the lighter where *Brenthis* most abounds and breeds. There is no doubt that occasional individuals of *Oeneis semidea* will be found far within the limits of the lower alpine region; for the fierce blasts of wind which sweep around these lofty elevations must sometimes hurl these feeble flutterers far down toward the wooded valleys, as I have myself seen; and there is no doubt that they can find their food plant all through the lower alpine region. Nevertheless, the contrast between the occasional and unwilling visitor and the swarms which in their season crowd the upper plateaus is very marked and significant. The localities where I have found them most abundant are the successive sedgy plateaus which flank the upper part of the carriage road on Mt. Washington, and especially the broad area between the sixth and seventh mile-posts, where the road takes a side turn, and which I call *Semidea* Plateau. So, too, one may find an aspiring *Brenthis* above the limits of the lower alpine region; but it is very rarely seen there, and the violets on which the caterpillar probably feeds will scarcely ever be found in any abundance within the upper alpine area. It seems fairly deducible from these facts that even the limited area of the barren heights above the White Mountain forests is divisible into two districts, each of which claims a butterfly as its own; so that in ascending

Mt. Washington, we pass, as it were, from New Hampshire to northern Labrador; for on leaving the New Hampshire forests and forest fauna behind us, we come first upon insects (there are others besides *B. montinus*) recalling those of the northern shores of the Gulf of St. Lawrence and the coast of Labrador opposite Newfoundland; and when we have attained the summit a butterfly greets us which represents the fauna of Atlantic Labrador and Greenland.

Interesting as this is, how very meagre such a showing appears by the side of our knowledge of the butterfly-faunas of the Swiss and Colorado alps, where the mountains rise to so much greater heights, and the mountainous area is so vastly more extended! In the Swiss mountains, where the alpine area is limited above as well as below, and the melting of the eternal snows keeps the whole region above the trees one of the choicest pasturages for cattle that the earth affords, the whole aspect of the butterfly world is different. A host of species in infinite numbers crowd about the blossoms, the springs, the very edges of the glaciers. Forms wholly unknown in the valleys below, or allied to but easily distinguished from them, meet one at every step. A species of *Oeneis*, very many of *Erebia*, several *Brenthis*, a number of *Melitaeidi*, a host of *Lycaenidi*, with species of *Eurymus*, *Parnassius*, and several *Hesperidae*, show how varied and striking the fauna is. Besides these a great many of the valley forms often accompany them, among which will be found our old friends *antiopa*, *cardui* and *atalanta*, so rarely seen with us above the forest. In the cordilleras of Colorado, where the snow-fields are far less important, and glaciers are practically unknown, we have a condition of things between the mountains of Switzerland and New Hampshire. The number of distinct forms is considerable, but by no means so large as in Switzerland. A couple of species of *Oeneis* are found here with several *Erebias*, and a *Brenthis* or two; some *Melitaeidi* also occur, most of which are also found some distance below the timber line, which is here vastly higher than at the White Mountains, being at about 10,000 feet. The *Lycaenidi* are abundant, and one finds a characteristic *Eurymus*, *Parnassius* (also found at lower levels), and one or two *Hesperidae* of the same group as occurs on the Swiss Alps. Indeed, the agreement of the typical alpine forms of Colorado and Switzerland is striking, and in strange contrast to the poverty of New Hampshire; the more so, as a large number of the additional generic types are not those characteristic of high latitudes. What the higher levels of the White Mountains would be as a home for butterflies, if a thousand or two more feet were added to their elevation and snow crowned the higher summits, it might be hard to say, but it would certainly be still very different from the fauna of the Swiss or the Colorado alps. Many of the generic forms which are common to them scarcely occur in eastern America; so that the difference between the three alpine

faunas we have mentioned accentuates the distinction which exists between eastern America and Europe, and the agreement found between western America and Europe.

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Those wishing details concerning the vertical distribution of Swiss butterflies should consult Speyer's *Geographische verbreitung der schmetterlinge Deutschlands und der Schweiz* (1858); or Meyer-Dür's *Verzeichniss der schmetterlinge der Schweiz* (1852). Brief notes of my own on Alpine butterflies will be found in the *Geology of New Hampshire*, i: 343, Bost. *journal. nat. hist.*, vii: 612, and *Appalachia*, v: 13, where the present excursus with slight variations was first published, and with the same map. See further, White on the Mountain Lepidoptera of Britain, *Scott. nat.*, v: 97; and also Mead, *Psyche*, i: 179, where some notes are given on the Alpine fauna of our Pacific slope.

Table of species of Oeneis, based on the egg.

Vertical ribs broken near the base of the egg into bead-like prominences.....**semidea**.
Vertical ribs continuing to the base of the egg unbroken.....**jutta**.

Table of species, based on the caterpillar at birth.

Anal prolegs much larger than the others. Terminal segment squarely truncate on either side, each side with two terminal hairs.....**semidea**.
Anal prolegs no larger than the others. Terminal segment regularly tapering on either side, each with only one terminal hair.....**jutta**.

Table of species, based on the mature caterpillar.

Supralateral stripe broad, discontinuous.....**semidea**.
Supralateral stripe narrow, continuous.....**jutta**.

Table of species, based on the chrysalis.

Head and most of the wings fuscous, in strong contrast to the yellowish abdomen...**semidea**.
Head amber and most of the wings light green, in no great contrast to the yellowish green abdomen.....**jutta**.

Table of species, based on the imago.

Upper surface of wings with no ocellate spots.....**semidea**.
Upper surface of wings with ocellate spots.....**jutta**.

OENEIS SEMIDEA.—The White Mountain butterfly.

[The mountain butterfly (Harris); the White Mountain butterfly (Scudder); brown mountain butterfly (Maynard).]

Hipparchia semidea Say, *Amer. entom.*, iii, pl. 50 (1828); *Entom. N. Amer.*, ed. Le Conte, i: 113-114, pl. 50 (1859);—Harr., *Ins. inj. veg.*, 3d. ed., 304, fig. 126 (1862).

Chionobas semidea Edw., *Morr., Syn. Lep. N. Amer.*, 351 (1862);—Scudd., *Bost. journal. nat. hist.*, vii: 621-626, pl. 14, figs. 2-8 (1863); *Proc. entom. soc. Philad.*, v: 20-25, fig

(1865);—Tenn., Man. Zool., 390, fig. 286 (1865); —Pack., Guide ins., 263, figs. 190-191 (1869); —French, Butt. east. U. S. [*Chionobus*], 294-250, fig. 72 (1886);—Mayn., Butt. N. E., i, pl. 1, figs. 1, 1a (1886);—Weeks, Ent. amer., iii:12 (1887).

Coenonympha semidea Morr., Syn. Lep. N. Amer.; 80 (1862).

Oeneis semidea Butl., Catal. Satyr. Brit. Mus. 163-164 (1868);—Scudd., Hitchc., Geol. N. H., i: 344-348. pl. A, figs. 2, 4, 6, 9, 11, 13, 14

(1874);—Grote, Can. ent., vii: 165-167 (1875); Am. nat., x: 129-131 (1876); Ill. ess. Noct. N. A., 81-85 (1882).

Chionobas also (pars) Boisd., Icon. hist. Lép., 197 (1832); (pars) Boisd.-LeC., Lép. Amer. sept., 222-223 (1833).

Satyrus eritiosa Harr.-teste Boisd., Icon. hist. Lép., i: 197 (1832) cf. Harr., Ent. corr., 177.

Figured by Glover. Illustr. N. A. Lep. pl. 26, fig. 4; pl. K. fig. 4, ined.

Kennst Du den Berg und seinen Wolkensteg? . . .
Kennst Du ihn wohl?

Dahin! Dahin!

Geht unser Weg.

GOETHE.—*Mignon*.

Or sometimes from your cool bournes, where it hid,
A butterfly soars fluttering, breeze-assailed,
Gay as those flowery gondolas that slid
Through sculptured Venice in old days, and trailed
Brocades and velvets where they sailed!

FAWCETT.—*Clover*.

Imago (1:9; 11:3). Head covered with long brownish hairs, with a few intermingled grayish white ones; a few scattered white scales behind the upper part of the eye among the black scales. Palpi blackish brown, fringed below with blackish hairs, changing above to brownish and intermingled there with a few whitish hairs; fringed above with grayish white or white hairs; within grayish. Antennae yellowish luteous, a little fuscous at the incisures; above, on the stalk, flecked slightly with blackish scales; the inner side flecked with white on the basal half, next the base heavily and broadly, beyond less so; the club almost wholly bright yellowish luteous, sometimes tinged a little with orange, on the basal half flecked with a few black scales above, the apical three or four joints a little dusky. Tongue almost uniformly luteous throughout, a little infuscated at the sides.

Thorax covered above with blackish, mingled with whitish scales and long, blackish brown hairs, mingled, especially behind, with others of a grayish and grayish brown color; outer edge of patagia fringed with pale hairs; beneath covered with blackish hairs, those of the coxae brown-tipped; legs dark reddish brown, the tips of the femora, the tibiae and the under side of basal tarsal joint flecked with white scales; spines and spurs pale yellowish red; claws dark reddish, paler at base; pulvillus pallid with a blackish transverse line.

Forewings (38:5) not greatly produced at the tip, the lower outer angle quite obliterated in the general curve; second superior branch of subcostal nerve arising at about two-thirds the distance from the origin of the first to that of the third superior branch; the fourth originating at a short distance from the third. Outer border of the hind wings well curved on the subcostal area, almost protuberant, especially in the female, at its junction with the median area. *Forewings* above uniform dull brownish fuscous, more or less slightly tinged with ochraceous; the whole costal edge marked with blackish brown and grayish white, generally quite distinctly, very narrowly at the tip; in the lowest subcostal interspace at a distance of the width of two interspaces from the margin, there is occasionally a minute gray-pupilled ocellus, sometimes barely discernible; the markings of the under surface appear slightly above at the apex of the wing. On the *hind wings* the markings of the under surface invariably appear upon the upper with considerable distinctness; the basal half is of about the same uniform tint as the fore wings, or a shade darker; the apical half is more or less distinctly mottled with grayish fuscous and brownish fuscous, sometimes darker next the margin; fringe of both wings alternately brownish white and blackish brown, the latter at the nervule tips; wholly blackish brown along the inner edge of the hind wings.

Beneath the *fore wings* are slightly paler than upon the upper surface; the costal margin is marked with blackish and whitish,—as a general rule, more so away from the base, broadening into a spot at the apex, which, however, does not usually encroach on the lower subcostal interspace, except to form a similar border to the outer margin as far as the second median nervule; when the ocellus of the upper surface is present, it is repeated beneath, just as minutely, but generally distinctly white pupilled; the only other marking which is generally seen upon all specimens is an indistinct dusky broad band, bordering the outer limits of the cell; it is most perceptible at its outer borders, one of which follows the nervule closing the cell, the other lies beyond, not quite parallel to it, but rather more nearly at right angles to the costal border; this band extends to the third median nervule, or if it exists beyond it, it is either continued as a fuscous blotch to the second median nervule, or the darker streak of its outer margin only is bent toward the base, subparallel to the outer margin of the wing, and continues as far as the first median nervule; besides these, there is usually a freckling of the wing with brown, either uniformly distributed or, more frequently, more distinctly on the outer half and especially the upper portion of it; or it is wholly confined to the outer half, sometimes clustering into short transverse streaks, especially between the extremity of the cell and the outer margin. Basal portion of the *hind wings* marbled with blackish or blackish brown and grayish white, very seldom uniformly distributed, the latter conspicuous only as a stripe bordering the mesial band and broadest next the costal border, the latter generally obscuring entirely the rest of the basal field and sometimes almost or quite obliterating the grayish band; the mesial band is very broad, colored more uniformly and darker in proportion to the rest of the wing than is usually the case with the allied species, marbled with blackish and grayish fuscous, occasionally tinged slightly with ochraceous, the black condensing, as it were, along the borders into narrow stripes, while the rest of the band is generally almost uniform in tint and does not often deepen in color from the middle; its interior margin, in passing from the costal border beyond the middle of the basal half, is generally bent outwards before reaching the subcostal nervule so as to form a slight generally angular pit; and then passing a little way beyond the subcostal nervule is bent very deeply into a V-shaped, occasionally U-shaped, depression, extending nearly to the inner border, the bottom of the depression reaching nearly, very seldom quite, to the origin of the first median nervule;—but there are not wanting specimens where the inner border of the mesial band crosses the wing with only a slight trace of any depression; the usual direction of the exterior border of the mesial band may be said to be that of two nearly or quite straight crenulate lines, bent upon the third median nervule, an interspace's width beyond the extremity of the cell, at an angle of about 85° or 90° , occasionally projecting into a slender tooth at this point; one end of the band strikes the costal border at such a point that a line drawn from it at right angles to the margin would strike about midway between the origin of the second and third subcostal nervules; the other strikes the inner border at a point as far from the tip of the first median nervule as that is from the middle of the subcosto-median interspace at the border; the angle of the exterior border of the mesial band is, however, often obscured by a more or less regular curve to the whole line, which again is now and then indented, but it almost invariably shows a tendency to return to this angular appearance, and the continuous baseward direction of the border as it approaches the costal margin is a peculiar feature in this species; beyond the mesial band, the wing is marbled with blackish brown, grayish ochraceous and grayish white, the latter almost always condensed, and connected so as to form a stripe bordering the mesial band, rarely tinged faintly with bluish; sometimes the blackish brown is collected into marginal spots at the nervule tips; very seldom indistinct whitish dots are present in the interspaces midway between the mesial band and the outer margin; occasionally, though but very seldom, the outer half of the wing is uniformly marbled throughout, and in some individuals the whole wing is covered with nearly uniform marbling or is so obscured by blackish that the markings here described are almost wholly if not quite indistinguishable; the nervures are not flecked with white.

Abdomen covered with dust brown scales and blackish hairs, the latter conspicuous above only near the base. Centrum of superior male appendages (33:4) forming with the upper surface of the body and the hook a nearly regular curve, depressed at their junction, the hinder edge of the hook scarcely arcuate in the same sense as the upper surface, so that the hook tapers regularly toward the tip and is fully four times as long as broad; lateral appendages very slender, scarcely more than half as long as the hook; clasps having the apical fourth equal, the tip broadly rounded, its upper half, as well as the apical half of the upper edge, furnished with numerous, equal, minute denticulations, directed backward and upward.

Measurements in millimeters.	MALES.			FEMALES.		
Length of tongue, 8.	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	21.5	2.3	23.75	21.5	23.5	24.5
antennae	8.5	9.5	9.5	8.6	9.6	10.
hind tibiae and tarsi..	6.25	7.	7.25	6.5	7.6	7.25
fore tibiae and tarsi..	2.	2.4	2.5	2.	2.25	2.1

Described from 30 ♂ 24 ♀.

Malformations. I have seen one specimen in which two of the joints in the middle of the antennal club are completely connate on the upper inner half so as to show no trace of a suture, while beneath the division is as distinct as usual; it is also broader beneath than above, and the termination of the suture is quite abrupt.

A male in my possession exhibits a supernumerary nervule crossing the middle of the upper two-thirds of the upper median interspace on one of the fore-wings; it is very distinct and the nervules above and below bend toward it a very little; it is slightly obscured by blackish scales, although markings are not to be expected at that point.

Secondary sexual distinctions. Androconia (46:1) tapering regularly to the apical thread, which occupies a full third of the whole; apical threadlets scarcely expanding. Extreme length of whole, .26 mm; basal breadth .022 mm.

Egg (64:8). Distinctly higher than broad, the base being full, the ribs pretty regularly rounded and destitute of distinct lateral corrugations, traversed transversely by scarcely perceptible delicately impressed lines, the granulations of the base resembling broken parts of the ribs; the latter about 26-30 in number, of which about 15-17 reach the summit; distant apart on an average .1 mm., the transverse lines in the middle of the egg 0.025 mm.; surface covered with excessively minute punctulations. Color a very pale, almost colorless straw yellow, changing after a time to a steel gray and shortly before hatching to lavender. Micropyle not at all depressed but exceedingly delicate, the outer cells very faintly defined, transverse outwardly, nearly regular toward the centre, averaging about .0165 mm. in diameter; micropyle centre .03 mm. in diameter, being a thinner yellow circle divided into several radiating cells. Height of egg 1.1 mm.; breadth .95 mm.

Caterpillar. *First stage.*—(70:5; 74:7). Head (78:6) pale yellowish brown, minutely and not profusely dotted with brown (later, dark brown), the sutures with a ferruginous tinge; mouth parts of the color of the head, the ocelli blackish. Body pale yellowish fuliginous (too light in the plate) the stripes brownish fuliginous, the dorsal stripe slenderer and much less conspicuous than in *O. jutta*; some days after birth the body is dark brown with a slight tinge of olive green, the stripes fuscous, the last segment pale brown. All hairs and other dermal appendages pellucid on blackish papillae; skin with a fuscous granulation. Last segment terminating on either side in a truncate plate, the truncation slightly oblique and furnished at either angle with a haired papilla. Anal prolegs excessively large. Legs and prolegs of the color of the body; spiracles black. Length 2.5 mm.; breadth of head .64 mm.; length of club-shaped hairs of body .01 mm.

Fourth stage. (74:1). Head (78:1) very pale fuliginous with a faint greenish tinge, the bottom of many of the large punctures black, and these arranged so as to form apparent bands having a brownish aspect in the position of the actual bands of the

next stage; labrum edged with blackish castaneous. Ocelli black. Antennae beyond basal joint fuliginous. Body very pallid brownish green beneath, sharply defined at the infrastigmatal line from the upper coloring, and carrying with it the color of the legs and prolegs. The whole effect of the upper part of the body is more pallid than beneath, but it is made up of a series of bands of which a very broad dorsal one and a laterostigmatal (and especially the latter) are nearly the color of the under surface and have in addition an interrupted black edging (the latter only above), leaving broad stigmatal and lateral bands of a strikingly pallid hue (the interruptions as in full-grown larva). Besides there is a narrow, interrupted, black dorsal stripe and the stigmata are black. The whole body is besprinkled with brownish papillae bearing short, recumbent, club-shaped, testaceous hairs no longer than themselves. Length 12 mm.; width of head 2 mm.

Last stage. (74:2, 4, 15). Head (78:8) brownish yellow or dull greenish brown, with seven bands of black or fuscous spots, situated on the prominences, one median, the others disposed in pairs; the median is broad and continues half way down the suture of the triangle; the next is parallel to it, of equal length, slightly narrower, separated by its own width from the median; the succeeding is slender and short, consisting of only ten or twelve black dots placed on the middle of the sides and having a horizontal direction; at right angles to this is the last, arising just in front of the base of the front legs, as short as the previous, still smaller and running at right angles to it; the punctulations are brown: there is a dark dot just behind and on a line with the antennae; sutures of the triangle dark brown. First joint of antennae dusky, second black, third reddish brown. Ocelli black, excepting the uppermost, which is reddish brown. Labrum black. Mandibles reddish, black-tipped. Maxillae dusky, the terminal joint darkest. Labium dark brown.

Body dirty yellowish green, furnished above with: first, a rather narrow black mediodorsal stripe, enclosing, on the apical half of each segment, little, rather pale green, longitudinal spots or dashes, those of the thoracic segments uniting to form a narrow line; the band tapers at either end of the body; second, a narrow, interrupted, inky black, supralateral stripe, composed of oblique dashes situated principally upon the anterior portions of the segments, the anterior extremities directed downward; third, a narrow, dark green, suprastigmatal stripe of the same width as the supralateral stripe, edged superiorly with inky black, which is slightly diffused downward at the base and apex of each segment, especially of the abdominal ones. The space between the stripes is pale yellowish green, tinged with faint reddish brown at the apical half of each segment, and on the sides also considerably tinged with reddish brown; below the suprastigmatal stripe, the sides are grass green with a flush of roseate, sometimes with an inconspicuous pale infrastigmatal line; the under surface is uniform pale grass green; the papillae with which the body is covered are pale and the hairs they emit dark reddish. Spiracles black. Legs dusky; prolegs of the color of the under surface. Length, 23.5 mm.; greatest breadth of body, 5.5 mm.; of head, 2.5 mm.; of mediodorsal stripe, .375 mm.; of space between mediodorsal and supralateral stripe, .875 mm.

Chrysalis (83:4, 5). Dull yellowish brown, the head, the thorax, excepting a fine dorsal line, and the middle of the wings, obscured by brownish fuscous; tongue, summit of head and veins of the wings blackish fuscous. Abdomen furnished with several rows of transversely oval or roundish, brownish fuscous spots, two on a segment, placed at equal distances from the anterior and posterior borders, and, usually, from each other; on either side is a laterodorsal row, where the spots are placed in a straight line and the row is lengthened by a single spot upon the metathorax; a lateral row, in which the posterior spot of each segment is placed below the anterior by nearly or quite its own length and is besides longer than the others; a laterostigmatal row, similar to, but usually not so conspicuous as, the lateral row; anterior to and a little below the posterior spot on each segment in the laterostigmatal series is a similar, slightly larger spot, most conspicuous on the anterior segments; an infrastigmatal series of similar spots, placed in a line and frequently confluent, or the anterior absent; beneath these is a medioventral band of fuscous dots and streaks; and at equal distances between this

band and the spiracles are two rows of roundish blackish fuscous spots, one on the middle of each segment; or, in the upper row, sometimes two spots at equal distances from the anterior and posterior border, the anterior spot the larger. Cremaster (86:18) bordered anteriorly by a large transverse, curving, fuscous stripe. Spiracles, with their lips, blackish. Length, 13.5 mm.; greatest breadth, 6 mm.; height of thorax, 5.25 mm.; height of abdomen, 6 mm.

Oeneis semidea was first discovered about half a century ago and described by Say from specimens sent him by Dr. Pickering and Mr. Nuttall of Boston. Very few specimens seem to have been taken since that time (most of them found their way to Dr. Harris' cabinet) until 1859, when I made my first considerable collections in the White Mountains. Ascending the highest peak on July 8th for the express object of finding this butterfly, I secured my first specimen at about a mile from the summit near the then foot path from the Glen; on ascending they became more abundant and although our party hastened over the ground, over forty good specimens were taken, and a friend even captured seven in his hands. Less than a week afterwards, in a little more than an hour's collecting, fifty-nine were taken—for in its season this butterfly is exceedingly abundant.

Geographical distribution. It was for a long time supposed by those who did not confound this insect with an allied form found in the north—in Labrador and Greenland—that it probably occupied a more restricted geographical area than any other butterfly in the world, being confined to the White Mountains of New Hampshire; but it has now been discovered among the Rocky Mountains of Colorado nearly two thousand miles away. Nevertheless the restriction of its range in the two widely separated districts which it occupies is extremely interesting and instructive. In the east not only is it entirely confined to the White Mountains of New Hampshire, but even here its range is very limited. As described already in this work, these mountains have been divided into three zones—mountain, subalpine and alpine. *O. semidea* is restricted to, and occupies the whole of, the highest—the alpine region from about 5,000' upward, where the fierce gales and wintry cold permit nothing but the scantiest vegetation. I have repeatedly visited these mountains for the express purpose of studying their peculiar fauna, and have lived for weeks in the woods and on the barren summits at the time when the butterfly was most abundant; yet I have never found it outside of this area, excepting on rare occasions, when a single individual has been swept down the mountain side by some sudden gust of wind. Many years ago I first published this statement, and no exception has been taken to it by the many entomologists who have since frequented this district in search of their favorites.

In the west it has so far been found only in a somewhat restricted area, considering the large number of high peaks which exist in the Rocky Mountain region, viz.: an area in central and southern Colorado, covering

about two degrees of latitude by a little more than a degree of longitude; but in every instance it has been found at a height of at least 12,000 feet. Thus to pass from north southward, I have taken it at Argentine Pass (13,000') and on Mt. Lincoln (12-13,000'), Mr. Mead near Twin Lakes on a mountain slope (13,000'), Dr. Packard and Prof. F. H. Snow on Pike's Peak (13-14,000'), and far to the south I found it on Sierra Blanca (14,000'). It has also been taken on Bullion Mt., wherever that may be, by Mr. David Bruce. As the height of the timber line in that region is about 10,000', the elevation at which the Colorado butterflies are found corresponds to the 1500'-2000' above the forest line at which they appear at the White Mountains.

Dr. Harris' assertion that "it has also been seen on the Monadnock Mountain [in southern New Hampshire] and will probably be discovered on the tops of the high mountains in our own State" is therefore wholly erroneous. I have ascended Greylock, the highest mountain in Massachusetts, more than twenty times, and at all seasons of the year and certainly could not have failed to see this butterfly did it occur there. Since Monadnock is a naked peak (though not rising above the normal forest line) it would certainly be a more probable habitat for the insect, but the limitation of its distribution in the White Mountains wholly forbids the possibility of its presence on an isolated mountain to the south, which only rises to the height of 3,700 feet.

Haunts. The butterfly is found most abundantly from about one-quarter to three-quarters of a mile from the summit of Mt. Washington, or at an elevation of from about 5,600 to 6,200 feet above the sea. It often alights on the flowers of *Silene acaulis* Linn., as well as upon some of the Ericaceae, particularly on a species of *Vaccinium*, and is also fond of the flowers of *Arenaria groenlandica*; but the best collecting places are the sedgy plateaus of the northeastern and southern sides of the mountain, where the aurelian will also obtain a good footing—a matter of no small importance on such a collecting ground. One favorite spot I have named Semidea Plateau; the carriage road crosses it just below the 7th mile-post. I have never found the butterfly at the head of any of the deep ravines.

There are other species of *Oeneis* confined to mountain regions and Meyer-Dür states of *O. aello*, the species occurring in the European Alps, that it inhabits the calcareous and central mountains; not the highest chains, as has been generally supposed, but rather the middle regions, from four to six thousand feet above the sea. He also makes the remarkable assertion that the butterfly appears—at least in Switzerland—only on *alternate* years; namely, those with even numbers. Professor Frey thinks this to be true only for special localities, but that every year it may be found in some of them; and Speyer also says that, according to Trapp, it appears every year, but in some years more abundantly than in others.

It has been generally supposed to occupy two years in its transformations.

Oviposition. I have made several experiments in obtaining eggs, but only twice successfully. In the first instance a single egg was obtained lying upon the ground. In the last, twenty eggs were obtained by imprisoning females in a lace bag over a pot of growing sedge on the very summit of the mountain. No eggs were laid upon the sedge itself, but three or four on dead roots and sticks; most were laid on the netting and a couple on the wire that supported it. It seems probable that the eggs are laid in nature near the base of the clumps of sedge which stud the plateau thickly, without regard to whether the tissue on which it is laid be living or dead;* with all my watching I have never been able to detect the females in the act of laying, but one often starts them up from deep down in the sedge. The eggs hatch in from nine to fourteen days, the exact time being uncertain from not knowing just when the eggs were laid. The females were imprisoned from July 21 to July 27, during most of which time there was a raging storm. They must have been laid between the 22d and the 26th and probably (from the better weather) on the last named day: one hatched the night of August 3-4, two on the 5th, one the 7th, two the 8th, and seven the 9th.

Food plant of the caterpillar. Nearly all the species of this family, so far as they are known, feed in the caterpillar state on grasses; but as the true grasses are rare in the inhospitable region where this insect is found, being replaced almost altogether by the allied group of sedges (which are fed upon by at least four species of European Satyrids, of three genera), it is not surprising that this has been found to be the food of the larva of *O. semidea*. I have previously maintained that lichens furnished them nourishment, because all the living caterpillars I had then found were upon or in very close proximity to one species (*Peltigera canina* Hoffm.); in one instance the animal was apparently feeding upon it; at least the head of the caterpillar was in juxtaposition to the lichen, and this had an eroded appearance; but the improbability of such a food-plant caused me long since to doubt my conclusion, and I have since repeatedly taken the caterpillar feeding upon a *Carex* which grows there in the greatest abundance, giving the more level portions of the range the appearance of pasturage. The species is *Carex vulgaris* var. *hyperborea*, formerly known as *C. rigida* var. *bigelovii*.

Habits of the caterpillar. In emerging from the egg the caterpillars bite a horizontal furrow beneath half or less than half the crown of the egg, through which they squeeze their way; sometimes they then leave the egg, but at others, perhaps in half the cases, they devour from half to four-fifths the shell. The caterpillars hatched by me remained quiet on dead

*I have seen one of the European species of *Coenonympha* (not captured) lay an egg in the fields on a stick of dry wood lying in the grass.

and living grass-blades in Cambridge for a fortnight or more and then were gradually lost. One only seemed a little more active than the others and ate slightly, as I thought, the tip of a cut blade of grass. The mature caterpillar may sometimes be found by day crawling upon the rocks, and the late Mr. Sanborn told me that he once found one feeding by day on *Carex*. But though, as already stated, I have repeatedly found the caterpillar by night feeding upon *Carex*, I have never found it by day excepting concealed under stones or crawling upon the rocks toward such a concealment; yet I have searched *Carex* and swept it with a net fifty hours by day to one by night, and search by the lantern is neither so easy nor so sure as by sunlight. I think therefore that its habit is to feed by night—soon after dark is the best time for search—and conceal itself under surface stones by day, generally on some flat or nearly horizontal surface. They spin little or no silk and fall readily to the ground when disturbed. They are very sluggish and coil themselves into half a ring when handled.

Pupation. In the early part of July 1869, the late Mr. F. G. Sanborn searched very carefully for the chrysalids of this species, spending ten or twelve hours in raising movable surface stones, and in four or five cases clearing away to the depth of several feet the smaller blocks of stone lying in the "rock rivulets," as he appropriately terms the slight gulleys, wholly without vegetation, which are scattered everywhere over the plateaus, and which mark the course of the surface waters after rain; he succeeded in securing only two living specimens; nine others were either infested by parasites, or were the empty shells of the previous year; they were all found imbedded between the sides of the rock and the long, dense, crisp moss surrounding it, between half an inch and an inch and a half below the general surface, where the caterpillars had entered. They were not attached to the rock or the moss, but lay in horizontal oval cells, evidently formed by the movements of the caterpillar before pupation; the most particular examination revealed no trace of any web or silken thread even as a lining of the cell. Mr. Sanborn's impressions, drawn mainly from a comparison between the slender number of specimens he obtained and the abundance of the butterfly, were that the healthier caterpillars penetrate even deeper into the ground; but as I have also found pupae under or beside surface-stones, and Mr. C. P. Whitney has discovered larvae ready for their change in similar localities, I am more disposed to believe that the place to seek them is beneath and beside the uppermost stones and especially at the edges of the "rock rivulets," where the vegetation is usually the freshest. To one familiar with the locality—a surface almost completely strewn with angular rock fragments, Mr. Sanborn's exploration will seem to have been a very successful one.

I leave the above paragraph as I wrote it fifteen years ago; but I have since spent two or three times as many hours as my eager friend, often with

the aid of others, and am sure that the places chosen by the larva for pupation are exactly those chosen by it for daily concealment, namely, the under side of surface stones, which rest either upon another stone or upon some other thing than the loose, disintegrated, gravelly rock which least retains moisture; a level, damp and cool, protected spot is that most sought for; here the caterpillar rests upon the lower surface with its roof grazing its back, and pushing away whatever may interfere with the smoothness of the spot changes to chrysalis without further ado. Unless some moss be at hand there is no semblance even of a cell; and even where moss is present there is sometimes no mark of a cell; and when found is due simply to the movements of the caterpillar, with an amount of silk scarcely enough to enable one to remove it and in any way preserve the form; no threads indeed are visible without a lens; and I have but once—and that was last spring—found a cell which was anywhere near complete, and this one lacked an upper surface; when the stone which served that purpose was removed, the uncovered cell was undisturbed by it, showing that no threads were attached to the covering stone. The caterpillar was lying on its back when found, May 31, and changed to chrysalis on June 2 in the valley below. Was then carried to the sea level at Cambridge, and the butterfly emerged on the early morning of the 19th. As this is earlier than its normal time on the mountain, its appearance was doubtless hastened by the favorable warmth of the lower level; four weeks is more probably its natural period.

Life history. This is a single-brooded butterfly; it usually begins to appear on Mt. Washington very early—the first week—in July, becomes exceedingly abundant before the middle of the month and continues until about the second week in August. On Sierra Blanca, in Colorado, I took a single rubbed male as late as August 29 and a tolerably fresh male on Mt. Lincoln on August 13. Mr. Bruce took them early in July. Mr. Sanborn gave July 4 as its earliest appearance in New Hampshire in 1869, and only one more specimen was seen before the 9th, although the weather was favorable. Morrison says “the first specimens appeared about July 1 [in 1874] and in a few days it became very abundant.” Mr. Dimmock took one the same year on June 28 and several on July 4 and 6. These may serve, I think, as average dates, and the butterflies will best be taken in the second and third weeks in July; they apparently lay most of their eggs during the last week of July; caterpillars have been found by Mr. Whitney, the late Messrs. Sanborn and Shurtleff, and by myself, nearly full-grown, between the 20th of July and the 2d of August, and others certainly full-grown on August 19 and in September. These must certainly have been born the previous year, as the eggs do not hatch before the first of August; and as all living chrysalids that have been found have been taken in the earlier part of the season, between June 10 and the early part

of July, it would appear as if two years must be required for the full cycle of changes, and that the winter is passed in two conditions, both larval, one just hatched or in a very early stage, the other full grown, or very nearly full grown, a whole season being required for the development of the larva alone. No one would be surprised at this if he were to experience the conditions under which these hardy creatures have to live.

Such a cycle of changes, though unprecedented among our butterflies, so far as their history is known, is supposed by some to be equally true of the alpine *Oeneis aello*, the young caterpillars of which are born at a like period and hibernate without feeding. If this were its regular habit, we ought to expect that, as is stated by some to be true of *aello*, the butterfly would fly only in alternate years in any one spot. But not only is this not true of our species, but no fluctuation in its numbers has ever been noted. It follows that if a period of two years is normally required for its transformations, there must be or have been some irregularity in its development by which a regular annual series of perfect forms should appear. If in the past only, then the butterflies of the even years have no immediate genetic connection with those of the odd years, and two parallel series are living on the same ground, subject to the same vicissitudes or to only such variations in them as alternate seasons may chance produce. If this should prove to be true, a very neat problem would be set before the modern evolutionist to determine, first, how such a condition of things came about, and second, what effect isolation has had toward developing two types of butterflies.

A few facts, however, lead me to believe that while a biennial cycle is the rule, there are certain exceptions to it every year, by which a perfect comingling of blood ensues and Nature protects itself against the danger of extinction that might ensue if one stage of larval existence were less able than another to contend with the difficulties of an exceptional season. Dr. Harris gives "June and July" as the season of the flight of the imago, the former date on the authority of the botanist, Oakes, who found them abundant in June, 1826. The part of the month does not appear from Dr. Harris' notes and I have always supposed it referred to the closing days of the month until 1886, after an excursion up the mountain in company with Mr. Roland Hayward, on June 6. Between us we saw, on no less than three different occasions in the alpine belt, a *Lepidopteron* which in each instance the observer thought was *semideca*; in the last case, the size, the flight, and the color were observed by me for at least fifteen seconds in broad daylight, at the nearest distance of just out of reach of my net; and were it not for the unexpectedness of the apparition, I should not have had the slightest doubt of its being *semideca*, for I know of no moth then flying there for which it could have been mistaken. It is possible, therefore, that Oakes also saw them early in June (when visits to the summit are excc-

sively rare) and that a supplementary brood of the butterfly annually appears at this time. In further confirmation of such an irregularity was the discovery of a caterpillar, curled up under a stone as if it had not yet at all left its winter quarters, and still in its penultimate stage, on June 10, 1887; indeed it had evidently some time before it in that stage and fed on grass for a fortnight, finally dying before another ecdysis; it was only 12 mm. long. It is evident that it had much the start of the caterpillars in their first stage, and probable that pupation could have been reached before winter set in, giving easy chance for the final change to butterflies the last of May or early in June; living chrysalids were found the same day and several chrysalis-shells from which the imago had escaped, which it did not seem probable could have passed the winter and come out in so fair a condition; but no butterflies were then seen, although careful watch was kept for them. It is indeed possible that this caterpillar of the penultimate stage was born from an early egg of the July butterflies of the previous year and would have developed to a late July butterfly, in time to lay eggs the same season, making the cycle in a single year. It is at any rate evident from these exceptional occurrences that we have much yet to learn of the history of semidea. A visit to Mt. Washington on May 31 of the present year when for over an hour the weather was warm, the air still, and the sun seldom obscured, brought no sign of this butterfly.

The European Alpine *O. aello* appears, says Meyer Dür, among the earliest butterflies of the Alps; it is seen soon after the snow melts, first on the lower grounds, at the end of May, last on the higher levels (corresponding more nearly to those to which our species is restricted) at about the beginning of July; and disappears in the same way from the end of June below, to the end of the first week in August above.

Habits, flight, etc. One would suppose that insects whose home is almost always swept by the fiercest blasts would be provided with powerful wings, fitting them for strong and sustained flight; but the contrary is true; they can offer no resistance to the winds, and whenever they ascend more than their accustomed two or three feet above the surface of the ground or pass the shelter of some projecting ledge of rocks, they are whirled headlong to immense distances until they can again hug the earth; their flight is rather sluggish and heavy and has less of the dancing movement than one is accustomed to see in the Satyrids; they are easily captured, though they fly singly, never congregating, and have their devices to escape pursuit: one is that when alarmed, and indeed at most times, they fly up or down the slopes, rarely along them, rendering pursuit particularly difficult; another that they will rise in the air to get caught by the wind, which often takes them out of sight in a moment; one I once followed with my eye whirled a good half-mile away, a thousand feet in the air, with a white cloud for a background. But the neatest device of all is specially exasperating; one

will settle on the ground a little distance off by a crevice in the rock-piles, and as you cautiously approach you will see it edge its way afoot in its spasmodic fashion to the brink of the crevice and settle itself; then if you come nearer it will start as if to fly away, but close its wings instead and fairly drop down the crevice, where you may see but not reach it; to repeat the process and get still farther down, if again alarmed by the removal of the upper rocks. In this way I have more than once followed one for a couple of feet downward in a pile of small, jagged rocks in one of the rock rivulets.

It rests on the ground, or on the leeward side of rocks, as I have often found it when searching on a cloudy day when it had not been on the wing. As soon as one alights it tumbles upon one side with a sudden fall, but not quite to the surface, exposing the under side of the wings with their marbled markings next the gray rock, mottled with brown and yellow lichens, so that an ordinary passer by would look at them without observing their presence; it is an obvious case of protective resemblance. The surface is generally exposed so as to receive the fullest rays of the sun, or else the creature falls so as to let the wind sweep over it, its base to windward. In either case, unless the wind be very severe, the fore wings are not closely tucked between the hind pair, but advanced so that the costal edge of the hind wings reaches the lowest, or the next to the lowest, inferior subcostal nervule, according to the degree of quiet assumed; but if at rest for the night or the wind be sweeping fiercely, the costal edges of all wings are brought together. The antennae lie parallel to the body-axis, or slightly raised, but, owing to the basal curve, in a plane slightly above it, droop at the tip and divaricate about 100° . In walking, it moves by a series of spasmodic starts, trailing the tip of the abdomen on the ground, while the axis of the trunk is raised about 30° above the surface of rest.

Dr. Meyer Dür describes the species of the European Alps as generally flying in little companies about rocky places, fluttering in a wavering manner around the Saxifragae and Ericaceae, but generally alighting, with wings erect, on blocks of rock and worn stones, where they are not easily caught.

Experiments. Observing that the butterflies appear to keep away from the immediate vicinity of the great ravines which penetrate deep into the mountain mass, as if they feared they would be swept down to lower levels than they liked, I thought I would see what effect a forcible and rapid transfer to lower levels would have upon vigorous butterflies. Accordingly one fine July day, I took three well-conditioned females (one of them caught just before imprisonment) down the mountain on the railway train, in a muslin cage over a growing sedge, where I could readily watch them. They remained quiet at first with wings tightly closed, but before we had made more than half the descent to the limit of trees they were visibly

affected, and by the time the tree line was reached (about 4500') the wings of opposite sides diverged at an angle of 30° , as if they were lips parted and gasping for air. Later they began to walk about, and when they stopped would tightly close their wings (as by habit) for about a minute, and then would slowly part them again,—in one case to as much as 60° – 70° . At the bottom (2800') I thought them dead, for they lay with parted wings upon their sides, but they gradually revived slightly. Still, when I set them free and tried to startle them only one would move; she fluttered two or three times and tried to fly away, but could not leave the spot where she ineffectually tossed up and down; I caged them again and they walked and fluttered about a little, but gaining no strength at the end of twelve hours they were killed. The difference in temperature at the two extreme levels was not worth consideration.

Now there are many other butterflies, denizens of the lower levels, which continually fly to the summit of Mt. Washington, and doubtless descend again. *Polygonia faunus* is one of these, and accordingly I carried down in company with *semidea* as many females of this species, together with some males, captured on the summit; but not caring to observe them closely on the way, they were enclosed in pocket boxes and let loose immediately on arrival at the base; they flew away with all their vehement vigor, not in the slightest incommoded by the sudden change.

I queried whether there could be any organ in the body which might have a different construction or amplitude in these two butterflies, which might serve as a better means of adaptation to differing air pressure in the one and the other, as the swimming bladder is known to do in some fishes. The only special organ I could think of was the so-called food reservoir, which, though furnished within, as shown by Burgess, with an arrangement of clustered hairs which seems adaptable for use in digestion, is nevertheless usually empty on dissection, and might receive air as well as honey through the apparatus at the mouth. But the dissections of the two species made for me by Mr. Emerton (61:47,50) do not lend much help; the organ is indeed larger in *faunus* than in *semidea*, but the difference does not seem to be very significant.

Parasites. Notwithstanding the physical difficulties with which this frail butterfly has to contend, it still has its full share of parasitic enemies, and they seem at times so numerous that one wonders how the creature can withstand this added source of evil. There is first a large *Ichneumon*, *I. instabilis* Cress., only one of which can live on one fat *Oeneis*, and which emerged from a wintering chrysalis on June 23. Next there is a *Pteromalus*, *P. chionobae* How., of which a single caterpillar may harbor a considerable number; those which I obtained emerged from the chrysalis on August 9; but on one occasion, I took twenty-five of their pupae from a single chrysalis and found that each had been itself attacked by a

hyperparasite, *Tetrastichus semideae* Pack., which comes to the friendly aid of our mountain butterfly. Still another supposed parasite, *Encyrtus montinus* Pack. (89:4), was obtained by Mr. Sanborn within the chrysalis of *semideae*, but whether strictly parasitic upon it was not determined; all we know is that it was found alive and winged within an old chrysalis case, early in July.

Desiderata. The hotel at the summit of Mt. Washington and the easy, if expensive, means of approach now enable one to carry on investigations on this insect far more advantageously than formerly, during the season (July-September) when they are open to use; and there are still some questions to clear up. We do not yet know anything of the larva between the first and penultimate stages, nor at what season these stages are passed; the natural length of the chrysalis period is not known, nor whether it ever passes through the winter. A careful and prolonged search under stones by the rock rivulets in the Alpine area in October before snows put an end to search would enable us to know most about the wintering condition, but it would have to be carried on under great difficulties, not to say dangers, because of the season. The same should be said of the early spring, which on the whole is the season when we now need the most help; a similar search, with a lookout for butterflies, in the latter half of May would be most desirable. The facts gained by such a search would help clear the doubt which now hangs over the life history of the insect. The early stages can perhaps be studied at ordinary levels by procuring the eggs on the mountain and feeding the caterpillar either on sedges or grasses. It would be well for the occasional visitor in the latter half of July to seize any rare sunny and windless day, especially before noon, to watch the female ovipositing, to find out the place and method of laying eggs; as the insect is very timid, this should be done with caution. Search should be made for this butterfly in July and August on all peaks which rise 2000 to 3000 feet above timber in the Rocky Mountains of Wyoming, Montana and the Northwest Territories of Canada.

LIST OF ILLUSTRATIONS.—*OENEIS SEMIDEA*.

<i>General.</i>	<i>Imago.</i>
Pl. 89, fig. 4. <i>Encyrtus montinus</i> , a parasite.	Pl. 1, fig. 9. Right hand upper surface male; left hand lower surface female.
<i>Egg.</i>	11:3. Both surfaces, plain.
Pl. 64, fig. 8. Plain.	33:4. Male abdominal appendages.
<i>Caterpillar.</i>	38:5. Neuration.
Pl. 70, fig. 5. At birth.	46:1. Androconium.
74:1. Fourth stage.	52:6. Side view of head and appendages enlarged, with details of the structure of the legs.
2, 4, 15. Full grown.	61:50. Side view of the digestive tract in the abdomen.
7. First stage enlarged.	
78:6-8. Front view of head, stages i. iv, v.	
<i>Chrysalis.</i>	
Pl. 83, figs. 4, 5. Side and dorsal views.	
86:18. Cremaster.	

OENEIS JUTTA.—The arctic satyr.

[The arctic satyr (Scudder); the barren ground butterfly (Maynard).]

Papilio jutta Hübn., Samml. eur. schmett., i: 25, figs. 614-615 (1806-1819).*Oeneis jutta* Hübn., Verz. schmett., 58 (1816);—Berg. Stett. ent. zeit., xxxv: 145-148 (1874);—Holmgr., Ent. tidskr., vii: 151-154, figs. (1886).*Oreas nubila jutta* Hübn., Syst. alph. verz., 6 (1822).*Chionobas jutta* Möschl., Wien. entom. monatschr., iv: 342 (1860); vii: 201 (1863); Stett. entom. zeit., xxi: 116-117 (1870);—Seudd., Proc. Entom. soc. Philad., v: 3-5, fig. (1865)—Pack.; Guide ins., 263, fig. 192 (1869);—Fern., Butt. Me., 77 (1884);—[Hulst], Bull. Brookl. ent. soc., vii: 109 (1884);—French, Butt. east. U. S., 248-249 [*Chionobas*] (1886);—Mayn., Butt. N. E., 2-3, pl. 3, figs. 2, 2a (1886); Fyles, Can. ent., xx: 131-133 (1888).*Satyrus balder* Dup., Hist. nat. Léop. France, suppl., 310-311, pl. 49, figs. 4-5 (1832).*Chionobas balder* Boisd., Guer., Icon. règne anim., ins., 487, pl. 80, figs. 1. 1a-1d (1829-1838); Icon. hist. Léop., 189-190, pl. 39, figs. 1-3 (1832);—Boisd.-LeC., Léop. Amer. sept., 216 (1833);—Herr.-Schaeff. Syst. bearb. schmett. eur., i, tagf., 68 (1843);—Christ., Stett. ent. zeit., xix: 309 (1858);—Schiodte, Berl. entom. zeitschr., iii: 149 (1859);—Rink. Naturh. bidr. beskr. Grönl., 64 (1860);—Morr., Syn. Lep. N. Amer., 71 (1862).*Eumenis balderi* Geyer, Zutr. exot. schmett., v: 43, figs. 981-982 (1837).

Figured by Glover Ill. N. A. Lep., pl. K. fig. 2, ined.

And I know the butterflies,
Sailing through the fragrant air,
Mark the heaven of your eyes,
And must long to enter there!

MARGARET DELAND.

... to reside
In thrilling region of thick-ribbed ice.
SHAKESPEARE.—*Measure for Measure*.

Imago (14:17). Head covered with long blackish brown hairs and a few shorter grayish white ones; a few scattered white scales behind, but not in conjunction with, the eyes. Palpi covered within as without with intermingled grayish white and blackish hairs, fringed with long black hairs above and beneath, and above with short grayish ones. Antennae dull yellowish brown, the under outer surface covered with dirty white scales; the basal half flecked with black on the apical third of each joint; above mainly covered with blackish scales, few on the club, interrupted rather narrowly with grayish white at the base of each joint, the paler color extending, interiorly, to the middle of the joint; tip of club a little dusky.

Thorax covered above with blackish brown and dark dirty yellowish brown hairs; beneath with blackish, mixed with a few dark grayish brown hairs; femora dark yellow brown, yellowish brown at tip; rest of legs yellowish brown below, dusky brown above; spurs, spines and claws, as in the previous species.

Fore wings strongly produced at the tip, the lower outer angle not very indistinct; second superior branch of the subcostal nervure arising scarcely more than half way between the base of the first and third branches; the latter and the fourth superior branch originating in close proximity; outer border of the hind wings almost truncate on the lower two subcostal interspaces. Above dark brown, the male slightly darker than the female. Parallel to the outer border of the *fore wings* and nearer to it than to the extremity of the cell is a broad band, dull yellow (♀), or more or less ochraceous (♂), extending from the costal to the internal nervure, generally interrupted only by the nervures (♀), or broken up into roundish or ovoid spots, often widely separated (♂), which encloses rather large, black, round or ovoid spots in the lower subcostal and lower median interspaces, and one of the same size or smaller, or even reduced to a point in the upper median interspace, absent in the male, the lowermost of these spots slightly nearer the border than the others; costal border, especially near base, indistinctly mottled with gray and black, the costal edge blackish; fringe pure white,

interrupted narrowly with black at the nervure tips. The male is also provided (43:2) with two black streaks of hair-like scales, one next the base below the median nervure resting upon and extending to its first branch; the second, separated by this branch from the first, rests upon the median nervure both above and below, divided by it and extending to the termination of the cell, having a small patch between the second and third median nervules. *Hind wings* with a band before the border similar to that of the fore wings, continuous, or nearly so, in both sexes and within it, in every interspace, a more or less distinct pale yellow dot, except in the upper median interspace, where there is a small eyelike spot, indistinctly pupilled with white; the lower median interspace occasionally develops a similar but indistinct spot; the separation of the band from the border is less distinct in the female than in the male.

Beneath. *Fore wings* slightly paler than on the upper surface; the whole costal edge mottled with black and white; apex and upper half of outer border either uniform gray from the equal commingling of dark brown scales, or, by the clustering of scales of the same color into spots, pretty uniformly marbled with white and dark brown or black; outer half of the wing with a yellowish (♀) or slight ochraceous (♂) tinge, seldom with any mark of the light band of the upper surface, excepting as a halo, distinct and large (♀) or faint and narrow (♂) around the spots of the lower subcostal and lower median interspaces, which reappear on this surface, the upper always, the lower generally, pupilled distinctly with white. *Hind wings* marbled with narrow, transverse, generally wavy bars of clustered grayish white and brown or blackish brown scales, sometimes one, sometimes the other predominating, the lighter colors being fainter or nearly absent on the mesial band, and generally most conspicuous next its outer limit; the mesial band is darker than the ground color, not very prominent but broad; its outer border, generally only edged narrowly with blackish, is deeply crenate excepting toward the inner border, where the curves are slight and broad or wanting; it extends from the costal border at a little more than two-thirds the distance from the base to exactly the extremity of the cell, in three very prominent arches, each of the first two occupying an interspace, the third broad and arching over two interspaces; from the extremity of the cell the border bends backward towards the base, with a prominent arch in the next interspace, but in the remaining, by which it reaches the inner border, a little nearer the tip of the submedian than that of the internal nervure, only slight curves or none at all; the interior border is much less distinct, starts from the costal margin at a little more than one-third the distance from the base, has an angular depression between the costal and subcostal nervures and a very deep and rounded one in the lower half of the cell; it strikes the median nervure at or a little within its first divarication and then, turned inward in a direction at right angles to the internal nervure, is lost in the next interspace. Costal edge mottled with black and white, the outer edge narrowly lined with black, before which is generally a narrow faint band where the grayish scales predominate over the black. The remainder of the wing is generally uniformly marbled, but occasionally the narrow dark line bordering the lower half of the outside of the middle band continues on in a straight line to the outer angle of the wing at the termination of the second subcostal nervure. The ocellus of the upper surface appears again beneath, very prominently pupilled with white, sometimes so much so as to appear almost altogether as a white spot; the spots in the other interspaces are generally larger, more prominent and paler; nervures not flecked with white.

Abdomen blackish brown throughout with a few tawny scales at the tip of the apical joint. Male appendages (32:5): Upper organ with the centrum scarcely arched longitudinally, so that its upper surface and the median line of the hook lie in nearly a straight line; hook considerably arched above, the under surface a little arcuate in a contrary sense, or nearly straight but deeply and roundly excised at the base, the tip scarcely uncinatate and the whole scarcely more than three times as long as broad; lateral arms very slender, nearly equal on the apical half, much more than half as long as the hook. Clasps with the apical fourth equal, the tip obliquely truncate, its scarcely produced upper angle being provided, like the apical third of the upper sur-

face, with five or six small but distinct, finely pointed denticles directed upward and backward, with single minute denticulations between them.

Measurements in millimetres. Length of tongue 8.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length, of wings	25.5		27.			27.
antennae	10.25		10.5			
hind tibiae and tarsi....	7.5		8.			8.
fore tibiae and tarsi....			2.			21.

Described from 2 ♂ 2 ♀.

Androconia (46:2). Tapering to the middle, then for a brief distance equal and then tapering again like a sharpened pencil point to the apical thread, which is not more than one fourth of the whole; apical threadlets expanding. Total length, .4 mm.; basal breadth, .032 mm.

Egg (64:2). Short and stout, barrel-shaped, the top domed, the base broadly rounded; largest in the middle and about one-fifth higher than broad; sides with about eighteen vertical ridges and furrows having a very zigzag course, the former pinched at the summit and buttressed at every angle by the thickened ends of cross lines, which scarcely extend half way across the interspaces and do not meet those of the next vertical ridge, but interdigitate with them; several of the ribs unite or die out as the egg begins to narrow above, or even before that. Color yellowish white when laid (Braun); afterwards the interspaces are dull plumbeous yellow, the cross lines, and summits of the vertical ridges silvery white. The micropyle rosette is a tracery of delicately margined irregular polygonal cells, growing slightly smaller toward the centre, the whole covering an area about .2 mm. in diameter, and appearing to overlie a thick, silvery white, chitinous mass (the common meeting ground of the vertical ribs), excepting for a clear central space .05 mm. in diameter, in which about eight kite-shaped minute cells distinctly radiate around a common centre, surrounded by a single row of the outer rosette; the largest of the outer cells of the rosette has a diameter of about 0.025 mm. Height of egg, 1.25 mm.; width, 1.1 mm.

Caterpillar. First stage. (70:2; 74:11). Head (78:14) obscure pale green, coarsely punctate, the punctae slightly infuscated at the bottom, ranged very regularly in oblique rows .03 mm. apart, each with an inconspicuous pointed hair, which scarcely rises above the level of the puncture, but is occasionally larger, or about .04 mm. in length; besides there are a few definitely arranged, stout, blunt, curving, pellucid hairs about .03 in length, arising from brown dots, viz., on either side three in a horizontal line midway up the face, of which the two inner are close together next the summit of the frontal triangle, and the outer forms the lowest of a vertical series of three; between the middle ones of the two series but nearer the upper is another; and there are others below all. Ocelli black; mouth parts of the color of the head, the mandibles slightly testaceous. Body largest at anterior extremity and tapering backward slightly, but on the final segments more rapidly; terminal segment terminating on either side in a bluntly conical point bearing a papilla and hair. Color pallid beneath, plumbeous above, with a brownish fuscous dorsal stripe, a moderately narrow supralateral line and a broad stigmatal band; papillae hemispherical; stigmata blackish fuscous; legs very pale brownish. Length 2.3 mm. at birth.

Second stage (87:17). Head very pale greenish brown with a pair of very faint equidistant vertical stripes on either side; ocelli black; mouth parts, excepting the dark testaceous edge of the mandibles, of the color of the head. Body above greenish gray, tinged with bluish green on the thoracic segments, especially in front; a dorsal stripe, dark bluish green in front, changing posteriorly through greenish brown to pale reddish brown, edged throughout finely and faintly with white; a suprastigmatal pale reddish brown thread; a broad greenish brown laterostigmatal band, more greenish in front, more reddish behind; an equally broad, cloudy and faint, dull greenish stigmatal band; the substigmatal fold dull yellowish; a ventrostigmatal pale brown band, and

the under surface with the legs and prolegs pale green, the legs a little infuscated. Hairs pellucid, seated on green papillae, slightly darker than the upper surface of the body. Spiracles minute and black. Length, 7.5 mm.; width of head, 1 mm.

Third stage (87:18). Head pilose, with three dark stripes on either side, continuous with those of the body. Body light green, with a dark dorsal stripe, a dark latero-stigmatal line and a dark stigmatal band which runs to the anal horns. Length, 10 mm. (after Holmgren).

Last stage. Head green, with six rows of brown punctures. Body pale pea-green with dark brown lines along the sides, and a greenish brown dorsal spot on each segment. Legs concolorous; spiracles black. Length, 32 mm. (after Fyles).

Chrysalis. Head amber, with a brown dash each side. Wings pea-green, outlined and streaked with brown. Abdomen pale yellowish green, with a darker green dorsal line, numerous longitudinal rows of brown dots, and the extremity roseate. Length, 16 mm.; breadth, 6 mm. (after Fyles).

Geographical distribution (18:2). This is a circumpolar species inhabiting both worlds and three continents. In Europe it was long supposed to be confined to points north of 61° N. Lat., in Norway, Sweden, Lapland and Finland, but has latterly been found in isolated spots somewhat south of this, about Stockholm and in the Baltic islands southeast of that city (Thedenius, Holmgren), about St. Petersburg (Möschler) and even as far as the neighborhood of Riga in Russia in Lat. 56° 30' (Berg). In Asia it is less known but it apparently occurs throughout the whole breadth of Siberia, as it is found on the northern banks of the Amur in eastern Asia (Bremer, Eversmann), which would mean farther south than its greatest southern extension in Europe, and perhaps to as much as five degrees or more, since the river in part of its course reaches Lat. 48°.

In North America it has been found in the western half of the continent by Captain Gideon Geddes, who obtained it at Emerald Lake, at a high altitude, in British Columbia, Lat. 52°, Long. 118°, and by Mr. Macoun, who took it in the Rocky Mountains beyond our territory. But just as on the eastern side of the old world it appears to be found much further south than on the western, so in eastern America, its range so far as known is much further south than on the other side of the Atlantic. The only authority who gives a very high northern locality is Rink, who says it occurs in Greenland, the southernmost extremity of which lies at about the altitude of Stockholm and St. Petersburg; but on the continent proper it has not been taken farther north than York Factory on the west shore of Hudson Bay about Lat. 58° (Geffcken). In the west it has also been taken at Albany River (Brit. Mus.) at Moose Factory, James Bay, in the latitude of the British Columbia locality (Haydon), and at Nepigon above Lake Superior (Fletcher); and in the east along the Atlantic coast of Labrador at Nain, Lat. 56° 24' (Boisduval), Hopedale (Möschler, Packard), and Square Island Harbor (Packard), the last at about Lat. 52° 30'.

Between these points the only places where it has been found are far south of either. One is the neighborhood of Quebec about 46° 50',

where it occurs at Gomin swamp about three miles from the city near Bergerville, and also at a marshy spot or moving bog called Lake Savanna (Bowles, Fyles), while another is at Ottawa, where Mr. Fletcher took one specimen in a city garden. Our last locality is somewhat further south still, and brings it within the limits of the United States and of New England, viz., the Orono-Stillwater bog just north of Bangor, Maine, (Braun), about $44^{\circ} 45'$, the point of its occurrence the farthest removed from the arctic regions in either hemisphere. Undoubtedly it will be found in similar localities in the region between this and the St. Lawrence.

Haunts and larval food plants. Wherever it occurs it is confined to morasses, and even to very limited stations within them. Holmgren calls particular attention to this, stating that it is found, on the rocky islands near Stockholm, only where sphagnum abounds and that a quarter of a mile therefrom in a marshy area of about fifty acres he has searched in vain for it; the latter lies higher above the surface of the water than the former, which on its part is also poorer in grasses. Exactly the same is true near Bangor, and Fyles describes the Quebec locality as a sphagnum marsh in which one sinks to the knee. The Orono-Stillwater bog is a morass several miles in extent, but jutta's flight is confined, as I learn from Professor Carl Braun, the discoverer of the locality, to a limited section only a few acres in extent. On visiting the place in company with Mr. Braun I found the bog at this point a level morass of sphagnum moss, walking in which with utmost care one always sank more than ankle deep in water; it was thinly covered with a small growth of spruce and juniper and sprinkled with little bunches or hummocks of *Pirus arbutifolia*, *Ledum latifolium* and *Kalmia glauca*; on these hummocks grew also, but sparsely, a little very thin grass and here and there a tuft of *Juncus articulatus* or a clump of *Sarracenia*. There was besides a slender, sedge-like plant less abundant here than the *Juncus*. On examination, we discovered that the *Juncus* grew almost exclusively in the very restricted area of the morass occupied by the butterfly, and hence we conjectured this must here be the food plant of the caterpillar. In the more open parts of the morass, the *Juncus* disappeared, as did also, to a great extent, the sphagnum, the latter being replaced by another sort of moss, which was accompanied by *Andromeda polifolia*, and by a great abundance of the slender sedge above mentioned.

Holmgren tried the young caterpillars which he hatched upon various plants from the morass, including cloudberry, moss, grasses and lichens, and they took readily to the grasses. Berg on the other hand asserts that a caterpillar, which lived with him for twelve days but died before its first moult, fed on a lichen (*Bryopogon*) which he gave it, deceived by my mistake in supposing *Oeneis semidea* fed on lichen. I can only think he was mistaken in supposing that the caterpillar of jutta actually fed upon it.

Fyles has recently raised the insect to maturity on *Carex oligosperma*. I find it takes readily to lawn grass.

Oviposition and larval habits. Holmgren secured eggs from imprisoned females which were laid indiscriminately on cloudberry, grass, lichens, and the walls and lid of the enclosure. Braun's similar experiment in Bangor resulted in only three or four eggs laid on the netting. Fletcher obtained eggs on netting on a female confined over grass. Holmgren's eggs hatched in 19 days, and Berg's in 16; those sent me by Mr. Braun in 14 days, Fyles' in 14, and Fletcher's in from 14 to 18 days. The young larva, according to Holmgren, is very sluggish, after the manner of satyrids, and it is from 7-9 days before the first moult occurs, but Fyles gives only five days for his Canadian specimens; mine on the contrary, received from Mr. Fletcher, passed nearly three weeks in the first stage, and Fletcher had the same experience with his. Fyles says it feeds at first head downwards on the edge of the blade, afterwards bites off the end of a blade, and thereafter feeds head upward from the bitten end, gradually retreating down the shortened blade; but one of mine, from eggs received from Mr. Fletcher, ate at the start head upward from the tip of a broken blade. It feeds while young both by day and by night.

Life history. I am mainly indebted to Mr. Braun for information concerning the seasons of this insect with us, which is single brooded, and, in his experience, first appears near Bangor in the last week of May and flies for about a month. The earliest one he has taken was caught May 22; the females appear about a week after the advent of the males and fly a little longer or until June 22, the butterfly living about three weeks. Eggs have been obtained by him June 13 and June 22. About Quebec they are said to appear from May 31 to June 15 by Fyles, who obtained eggs on June 17. Mr. Fletcher at Ottawa obtained eggs July 3. In Labrador Möschler says they are found in June and July. In Sweden they began to fly one year in considerable numbers, according to Holmgren, on June 12, females were first taken on the 14th and by July 3 only females were to be found and these outflown; males had disappeared by June 26, and eggs were obtained June 30 to the number of ninety from four females. Berg, at Riga, obtained an egg laid on June 9.

In Europe, according to Holmgren, the caterpillar moults twice before winter, when it goes into hibernation and completes its transformations in the spring; but in Canada, according to Fyles, the only one who has carried it to maturity, it moults four or five times before hibernation, and scarcely feeds more in the spring, changing to chrysalis April 21; how long the chrysalis period lasts he does not state. From observations the present season I find that in changing its skin the first time the little caterpillar is motionless for at least three days.

The male while living possesses no odor perceptible to the human senses from the discal streak of androconia on the front wing.

O. aello of the European Alps is more nearly allied to this species than to any other European form or to *O. semidea*. Indeed the two species discussed in this work belong to distinct sections of the genus.

Habits, flight, and posture. I have only once seen *jutta* in flight, and then only for a second as one flew to my feet and was captured. Mr. Braun tells me that it has rather a quick flight, is hard to catch, rarely rises above the tops of the *kalmia* and other low bushes of the swamp, seldom alights, and is fond of circling around the clumps of juniper which occur here and there. When it alights it is generally upon the tree trunks, and in the pairing season, the female, according to Holmgren, usually rests high up on the tree, and it is in this search after females that the males fly around and up the trees.

It is easily startled; when it walks, it moves by little starts, with each movement advancing less than a fourth of its length, the wings parted from each other either less than 45° or about 100° ; and if blown upon when at rest it at once tucks its fore wings between its closed hind pair to reduce the surface affected; but seems hardly to be disturbed when the antennal tips are tickled with a hair.

When at rest for the night, hanging from the muslin roof of the enclosure in which it was placed, I noticed that its legs were sprawled widely apart, the wings hung back to back, the costal edge of the front pair a little below that of the hind pair, and the antennae, arched about equally at the two ends, the main stalk at an angle of about 100° with the costal edge of the fore wings, were raised above the plane of the body by 45° , and divaricated about 100° . Resting during the day it assumes much the same position, but the fore wings are then brought forward so that the costal edge is at right angles to the axis of the body and the antennae are parted at right angles.

Enemies. We know nothing as yet of any parasites of this insect; but Fyles states that he once lost a specimen through a kingbird, *Tyrannus tyrannus*, which "gave chase to the butterfly, and, after much doubling and twisting, caught it and disposed of it effectually."

Desiderata. Our main need is a better knowledge of the later stages of the caterpillar and of the chrysalis, and the characteristics of its pupation with the habits of the caterpillar in the spring; the existing descriptions are quite insufficient. Where in a morass, mostly under water, can the half grown larva find a suitable place to hibernate; and where in the still higher waters of spring can the caterpillar securely pupate? Mr. Edwards found that caterpillars hatched from June eggs sent to West Virginia from Montreal would eat nothing, but seemed disposed to hibernate at once. Is this ever the case in their home? The difference between the observations of Holmgren and Fyles also needs explanation. Do the differing accounts indicate that the insect is sometimes one year and sometimes two years in

completing its cycle of changes? It would hardly seem possible that Holmgren's young caterpillars could feed up in the spring to appear upon the wing at the early date of their normal appearance in Sweden. Or is it another instance of the greater intensity of life in America? The brief and regular time of the butterfly's flight would seem to indicate uniformity in the larval habits, and the unusual temperatures to which the northern insect was subjected may account for that exception in which the caterpillars did not survive. Search for the butterfly should be made in the first half of June in all sphagnum morasses in northern New England and Canada to learn more of its distribution; it is useless to search for it outside of such a spot. North-western subarctic America should also be searched. Does the pupa undergo its transformations in a cell as in *O. semidea*, or hanging like ordinary Nymphalids? Fyles does not tell us. Has the creature any parasites?

LIST OF ILLUSTRATIONS.—*OENEIS JUTTA*.

<i>Egg.</i>	<i>Imago.</i>
Pl. 64, fig. 2. Colored.	Pl. 14: fig. 17. Female, both surfaces.
<i>Caterpillar.</i>	33: 5. Male abdominal appendages.
Pl. 70, fig. 2. Caterpillar at birth.	43: 2. Male upper surface fore wing, to show discal streak.
74: 11. Caterpillar at birth, colored.	46: 2. Androconium from the streak.
78: 14. Head of caterpillar, first stage.	<i>General.</i>
87: 17. Caterpillar, second stage.	Pl. 18, fig. 2. Distribution in N. America.
18. Caterpillar, third stage.	

CERCYONIS SPEYER.

Cercyonis Speyer, Bull. Buff. soc. nat. sc., Minois Scudd., Syst. rev. Am. butt., 5 (1872)
ii: 241 (1875). (Not Minois Hübner.)

Type.—*Pap. alope* Fabr.

Flusheth the rise with her purple favor,
Gloweth the cleft with her golden ring.
'Twixt the two brown butterflies waver,
Lightly settle, and sleepily swing.

JEAN INGELOW.—*Divided*.

Look here, upon this picture, and on this,
The counterfeit presentment of two brothers.

SHAKESPEARE.—*Hamlet*.

Imago (52: 4). Head small, pretty uniformly tufted with rather long hairs; front full, depressed a little above, protuberant in the middle below, scarcely narrower than the eyes, broader than high, the middle of the upper posterior border projecting roundly a little between the antennae, lower edge rather abrupt, pretty well rounded; vertex small, depressed, the anterior edge corresponding reversely to the posterior edge of the front; flanks pretty full; upper border of the eye distinctly angulated opposite the posterior base of the antennae. Eyes of moderate size, pretty full, naked. Antennae inserted in the middle of the head, in a broad, shallow pit separating the front and vertex, their interior bases in close contiguity and the exterior edge striking the flanks; considerably longer than the abdomen, composed of from forty to forty-five joints, increasing very slightly and very gradually in size on the apical third, the last two joints diminishing to a broadly rounded apex; transversely circular, the club a little depressed, minutely carinate along the under surface. Palpi more than twice as long as the eye, slender, compressed, the apical one-third as long as the middle joint; profusely clothed beneath with long, above with short hairs, all compacted in a vertical plane.

Prothoracic lobes very small, appressed at base to a thin pellicle, suddenly expanding above to a transverse tumid mass, comparatively large, globose and well rounded interiorly, exteriorly extending to a downward curving, digitate, bluntly pointed projection, tapering both in height and length; interiorly it is as long as high and the breadth exceeds the length about four times. Patagia moderately convex, the posterior lobe pretty broad at base, scarcely twice as long as broad, rapidly and pretty regularly tapering, the interior edge nearly straight, the exterior concave, the tip bluntly pointed.

Fore wings (38:1) not greatly produced at the apex; costal margin pretty regularly though not greatly convex throughout; outer margin much the same, but more or less flattened along the middle; inner margin straight, the lower outer angle pretty well rounded off. Costal nervure greatly swollen at the base for a distance equal to the width of the cell; first two superior subcostal nervules arising close to the tip of the cell; the latter a little less than half as long as the wing and but little more than twice as long as broad; median a little enlarged at the base, very gradually diminishing in size half way to its first divarication; submedian with a basal enlargement similar to that of the median. As an accessory sexual peculiarity, the male has the whole of the upper surface of the cell and all the region immediately surrounding it covered with rather long recumbent hairs, directed from in front backward; there is also in the lower median interspace near its base and also below and a little within it, as well as in the medio-submedian and submedio-internal interspaces, rather small, generally triangular patches of partially erect scales, giving a peculiar appearance to the wing.

Hind wings with the costal margin arched at the base, pretty regularly convex beyond, the upper outer angle very well rounded but a little prominent, outer border scarcely angulated at the upper median nervule, on either side of it but little convex and minutely crenulate; inner margin slightly convex, beyond the abdomen roundly excised. Nervule closing the cell striking the median a little beyond its last divarication and the subcostal as far beyond the basal curve of the lowest branch; first median nervule originating opposite the basal curve of the last subcostal nervule.

Androconia exceedingly slender, tapering from the very base to the merest thread with great regularity, expanding at tip by a short and rather thick bunch of lateral threadlets.

Fore legs very small, cylindrical, the tibiae nearly one-third the length of the hind tibiae; tarsi not so long as the tibiae, consisting, in the male, of an undivided joint, terminated by a produced, constricted, conical apex, bearing a resemblance to a central spine; in the female, of five very indistinct joints, the first three-fifths of the tarsal length, the others decreasing slightly and regularly to the tip and apparently quite unarmed; leg wholly unarmed excepting by the rather sparse clothing of long hairs, which spread a little, especially on the outer side, and in the male more than in the female; middle tibiae a little more than three-fourths the length of the hind tibiae. Tibiae furnished, on either side of the under surface, with a row of rather distant, moderately long, forward and a little outward directed spines, the terminal ones developed into long and slender spurs; first joint of tarsi longer than the next three joints together, the second next in length and twice as long as the fourth which is shortest; the third and fifth equal; whole under surface of the tarsi liberally supplied with rather short spines, confined mostly to a double median row and, on either side, a lateral row, the latter the larger and their terminal spines in each joint slightly curved and a little larger than the others; claws regularly and rather strongly curved, quite slender, scarcely compressed, bluntly pointed; pulvillus minute, transversely ovate, upon an enlarged peduncle; paronychial consisting on either side of two members, an upper, slender, straight, regularly tapering and very pointed lamina, as long as the claw; and a lower, incurved, short, feathery, equal ribbon, half as long.

Male abdominal appendages: upper organ rather slender, the centrum strongly compressed, laterally triangular, scarcely arched above, the hook very slender and equal, elegantly curved, its upper edge in direct continuation of that of the centrum, strongly and equally compressed, considerably longer than the centrum, bluntly pointed at tip; sides of the centrum supporting near the middle a pair of lateral arms, slender, taper-

ing, pointed, directed backward, incurved, less than one-third as long as the hook. Clasps strongly compressed, not incurved, rather broad at the base, but narrowing throughout, mostly on the distal half, which is bent a little upward and terminates in a blunt point; upper margin of the clasp about as long as the hook of the upper organ.

Egg. Somewhat short barrel-shaped, but diminishing greatly in size on the upper half, the apex, which is broadly truncated and distinctly separated from the sides, a little convex; higher than broad, broadest in the middle of the lower two-thirds, the base slightly convex, the sides a little inflated; sides furnished with a large number of distinct, but not very prominent, longitudinal ribs and traversed transversely by numerous delicate, raised lines; at the summit the longitudinal ribs are connected by an irregular, wavy rim, between which and the micropyle is a similar circle; surface minutely granulose. Micropyle formed of minute, roundish, polygonal cells, decreasing in size toward the centre, bounded by fine lines.

Caterpillar at birth. Head regularly rounded, of equal height and breadth, the upper half, as far as a line running from the largest ocellus to a point about one-third way down the frontal triangle, but avoiding the ocellar field, pretty coarsely and rather abundantly punctured; anterior ocellus twice as large as any of the others. Body depressed above between the laterodorsal rows of appendages; terminal segment squarely truncate, the only indication of the subsequent bifurcation being in the papillae which give rise to long terminal hairs. Body furnished with elevated papillae giving rise to peculiar appendages and placed in horizontal rows, as follows: a thoracic mediiodorsal series, and the following over the whole body; a laterodorsal series, two to a segment (the posterior slightly the lower and its appendage growing continually shorter toward the posterior part of the body), the appendages of both directed forward on the thoracic, backward on the abdominal, segments; a suprastigmatal series, one to a segment, centrally placed, and its appendage directed forward; and an infrastigmatal series, two to a segment, the posterior a little higher than the anterior, the appendages of both directed backward. The appendages above the spiracles (86:39) consist of exceedingly long, scarcely tapering, compressed hairs, bent very strongly a little above the base, so as to be nearly horizontal, the convex surface distantly and rather sinuously serrulate; those below the spiracles are somewhat shorter and not so greatly curved. Legs rather long, not very stout, tapering, the claw rather short and stout, tapering rather rapidly, pretty strongly and regularly curved; ventral prolegs armed with five, anal prolegs with seven hooklets, arranged in a slight curve, equal, the basal half nearly straight, the distal strongly curved, distant from one another by less than their own width. Spiracles circular, a little elevated, on slightly constricted stalks.

Mature caterpillar. Head appressed globose, a little flattened above, pretty full in front, broadest at the upper limit of the ocelli, narrowing but little above, the surface uniformly and rather sparsely studded with small, bluntly conical papillae. Ocelli five in number, four in an open curve, of which the first, third and fourth are similar in size and equidistant, the second much larger and approximated to the first, the fifth posterior and at the angle of an equal armed right angle uniting the second and fourth. Frontal triangle slender, with straight sides, reaching the middle of the upper half of the head, nearly twice as high as broad. Labrum narrow, nearly as long as wide, angularly and considerably emarginate. Antennae small, the first joint mammiform, the second inconspicuous, hardly half as long as broad, forming a small and tapering ring, the third cylindrical, about two and a half times longer than broad and less than half as broad as the first, bearing at tip a not long, tapering bristle, and, laterally, the minute cylindrical fourth joint. Mandibles stout, broad, chisel edged.

Body cylindrical, slightly flattened beneath, largest at the second abdominal segment and tapering equally forward and backward as far as the fifth abdominal segment and then more rapidly; anal horns short, slender, conical, widely separated, the segment truncate between them. Abdominal segments divided above by creases into six sections, of which the anterior, as far as the spiracles, is twice as large as one of the others which are equal; the second and third thoracic segments are divided into five

equal sections. Surface covered abundantly with minute, conical papillae, each bearing a backward-directed blunt-tipped or minutely fork-tipped hair two or three times as long as the papilla. Spiracles minute, oval, lenticular. Legs small, conical. Prolegs rather stout, short, conical.

Chrysalis. On a side view the ventral margin is perfectly straight below until the wing cases are reached, then it is gently, slightly, and broadly swollen, beyond which it is again straight on the tapering abdomen. The anterior margin is straight or slightly full, at scarcely less than a right angle with the ventral margin, sharply angled next it and in the opposite direction melting into the thoracic ridge, which is full, well rounded and moderately high, separated from the abdominal arch by a gentle angulation. The dorsum of the first four abdominal segments and the metathorax is very gently and broadly arched, so that this part of the body is subequal, beyond which it falls rapidly away toward the cremaster, but with a tolerably strong arch. The cremaster is inclined at an angle of about 45° with the ventral surface of the abdomen, equal as viewed laterally. Viewed from the back the ocellar tubercles are connected by a straight line and separated from the basal wing tubercles (each of which is a little farther from the neighboring ocellar tubercles than the latter from each other) by a uniform concavity; above the basal wing tubercles, which are scarcely prominent, the body is equal nearly to the tips of the wing cases and then tapers, at first slowly afterward rapidly, to the cremaster, which continues the tapering form to the squarely truncate tip. The wings reach the extremity of the sculptured portion of the fourth abdominal segment, the tongue slightly surpassing them and the antennae slightly shorter than they.

This is an American genus with a considerable number of species, mostly occurring in the western half of the continent, but whose limits and relations are not yet clearly determined. The dozen nominal species are all variable and run into one another by intergrades, and indeed probably cross with each other wherever their boundaries overlap. In eastern America there are not more than three species, occupying successive belts of latitude, which also overlap. In New England the genus is represented by two species, a northern and a southern, which meet on common ground in the middle portions of the district.

It has been generally conceded of late years that these two types of butterflies were only dimorphic forms of a single species, and I have myself shared in this view, which has been supposed proven by the breeding experiments and direct comparisons of a large amount of material made by Edwards, who, far more than all other observers together, has increased our knowledge of the natural history of these butterflies.

He has instituted comparisons between them at every stage of life, and while he sees differences between caterpillars and chrysalids born of different types, he finds no constant and universal distinctions; while as to the relation of the early stages to the butterflies, he has proved by breeding that "south of the belt of dimorphism," as he calls that strip of country where *C. alope* and *C. nephele* both occur, "*alope* produced *alope*, but inside the belt, *alope* produced intergrades, and *nephele* produced *alope* and also an intergrade . . . That *nephele*, north of the belt, breeds true is certain, because the intergrades and *alope* are not found here." This

would be conclusive if the complete parentage in each case were known; but as only the mother was known in any case, another explanation is not only possible, but in view of all the facts probable. The intergrades found throughout the belt forming the northern boundary of the typical alope and the southern boundary of the typical nephele seem to be far more easily explainable on the hypothesis of hybridism, since they occur only where such a phenomenon is possible, and wherever it is possible. The same argument applied to the case of *Basilarchia*, as has been done by Edwards, would logically prove more than he would agree to, viz.: the specific identity and trimorphism of all the eastern species excepting *B. archippus*. That the species of *Cereyonis* here described are certainly distinct I would by no means maintain; only that in view of the facts of distribution, it seems more probable that they should be looked upon as having reached in their development the stage of specific distinction, while they are readily fertile *inter se* and produce intergrades where they meet on common ground. It would perhaps be possible by introducing a considerable number of nephele into a southern locality far removed from the "belt of dimorphism," or, as I should rather call it, the "bastard belt"; or by the introduction of alope into an equally removed northern locality, to produce in free nature intergrades at those points. But if such an experiment failed, it might easily be presumed that the conditions of life were not sufficiently favorable to the introduced form, or that the results were overlooked. It is a difficult question to settle, but the progress of experiment and research will doubtless one day determine the matter.

The butterflies of this genus have ample wings of a uniform rich dark brown above, the outer margin pencilled with two or three darker lines and preceded by a few (on the fore-wings by one, or two; on the hind-wings generally by one) darker ocellated spots, usually confined to the lower subcostal and lower median interspaces; those of the fore-wings are sometimes enclosed in a broad yellowish band; beneath, the wings are irrorate with short dark streaks on a lighter brown base, the markings of the upper surface are repeated and, on the hind wings, often accompanied by additional ocellated spots, not equidistant from the outer border.

There is but a single brood each year, the butterflies flying from mid-summer onward and the caterpillars hibernating as soon as born, as in the allied European genus *Minois*; the chrysalis is attached by its hinder extremity to blades of grass, etc.

The eggs are short barrel-shaped, furnished with numerous longitudinal ribs. The juvenile caterpillars are stout and furnished with exceedingly long, compressed, geniculate appendages, bent backward, excepting those of the dorsum of the thoracic segment, which turn forward presenting a peculiar contrast. The mature caterpillars are simply pubes-

cent, the head round and equal, and both head and body green and furnished with several longitudinal, continuous stripes of lighter and darker green; the last segment is briefly and slenderly forked. The chrysalis is well rounded, has an alar ridge, angulate ocellar prominences, and a rapidly tapering, pointed, non-carinate abdomen.

EXCURSUS II.—THE CLOTHING OF CATERPILLARS.

And what's a butterfly? At best,
He's but a caterpillar, drest.

JOHN GAY.—*The Butterfly and the Snail.*

THE appendages of caterpillars are simply special developments of the cuticle. Almost without exception they are arranged in longitudinal series along the body, but sometimes, especially where the segments of the body are divided into a large number of transverse divisions by creases in the skin, they are also arranged in transverse rows across the body. As a general rule, however, the latter arrangement is subordinate to the former, although many naturalists, studying their disposition separately on each joint of the body, have described them as if the transverse arrangement were the more important. That this is not so is plain from the fact that in the longitudinal series, where they are on separate pieces, they are clearly aligned, which is very often not the case when on one and the same piece they are viewed transversely.

This special development of the cuticle may take form in various ways. The simplest of all and the most universally distributed, even the only clothing of considerable groups, is that of minute papillae, hardly visible except by artificial aid. These papillae are usually of a conical shape, though sometimes more or less hemispherical, and generally support a hair; or they may take the form of simple, lenticular, blister-like, naked elevations, as in many Papilioninae, where they are often highly colored or gleam with a metallic lustre. Sometimes the papillae are smooth, naked and hemispherical, the base surrounded by a ring of color giving them the appearance of ring-like spiracles, scattered over the body in definite series. These are found only, as far as I know, on the caterpillars of the Lycaenidae, and then only in their earliest stages. But in many other caterpillars the papillae are developed as large, roughened, wart-like prominences, often themselves covered with subordinate papillae or with bristles, as in some Nymphalidae and the earliest stages of some Papilioninae. Again such a wart or tubercle may be considerably prolonged and bristle with rough projections or papillae all along its surface, as in the full grown caterpillars of the Nymphalidi, the most striking instance of which in our fauna is found in *Basilarchia cros* of the southern states.

For these papilliform bodies, however developed, are rarely simple. They nearly always terminate at the summit with a single tapering hair, and in this form they very generally cover the body of the caterpillars of all butterflies, however naked they may appear, however hirsute, or however bristling with spines. In the earliest stage, especially in the young of many Nymphalidae and Lycaenidae, the hairs are of excessive length, and microscopically spiculiferous or serrate. Sometimes the hairs are clubbed at the tip or trumpet-shaped, as with many of those found on the body of Pierinae, as also upon the Hesperidae in their earliest and occasionally in their later stages. The trumpet-shaped or club-shaped hairs appear to be hollow canals through which fluids may be forced, for one may discover the use of the expanded and probably hollowed extremity, in the somewhat rapid appearance of the minutest possible globule of fluid at the tip of a hair where none could be seen shortly before. Not infrequently the hairs are of equal size throughout and truncate at the tip, as in some Pierinae and Lycaenidae, but neither in this case nor the preceding are these specialized hairs the only ones found upon the body, but they are certain special hairs, often assuming a definite position amid a mass of simple tapering hairs, seated on precisely similar or simply smaller papillae. In very rare cases the hairs may even be forked; we have in our fauna only a single striking instance of this, in the caterpillar of *Iphiclidides ajax* at birth, but such instances, none of which I believe have been specially noted before in Lepidoptera, must be excessively rare. Reaumur figures the larva of one of the hymenopterous family Tenthredinidae with similar appendages at maturity.

If we follow the caterpillars of the Vanessidi from their first stage, in which we find the simple papilla terminated by a long hair, we shall find that after the first moult this papilla is considerably larger, while the hair is diminished very much in length and importance; and following it stage by stage we see the papilla at last developed into a horny spine terminated at the tip in a little bristle, and armed all along its sides, often in regular series, with secondary spinules which also terminate in a bristle and bear minute, setigerous papillae. Between these juvenile and mature stages there is every development of this spine, and if we look through the entire series of the Nymphalidae we shall find a considerable variety in the form which these spines assume (Pl. 86). In some, as in *Eu Vanessa antiopa*, the main spine is only furnished in the final stage with minute bristle-bearing papillae in place of the spinule with its armature; and the main spine in this case is prolonged to an excessive extent, although not to so great a degree of slenderness as in *Heliconia*. In others, the main spine becomes rather a coriaceous conical tubercle beset with bristle-bearing papillae, as in the Melitaeidi and many Argynnidi.

Finally there is another form of appendage, which differs from the others

in its soft flexible nature. We have an approach to this in all the appendages of the Melitacidi and Argynnidi, and especially in the elongated tubercles of the first thoracic segment of many Argynnidi. But in all of these cases these tubercles are covered with bristle-bearing papillae of a conspicuous kind, while in those with which we close this summary, the tentacles, as they may perhaps better be called, are to all appearances simply fleshy masses; but on a close examination they also will be seen to be covered with minute downy hairs, each hair arising from a little basal papilla. These fleshy filaments occur in our New England fauna only in two species of widely differing groups, viz., the caterpillar of *Laertias philenor*, where they are arranged in several rows along the body and are often highly colored, and in *Anosia plexippus*, in which as in other *Euploeinae* there are but two or three pairs of these filaments of varying length. In both of these instances, the filaments are much more fleshy than in the case of the elongated thoracic tubercles of the Argynnidi, as is quickly shown in the attempt to inflate the caterpillar skin in hot ovens, when these parts usually contract to the last degree, and so are difficult to preserve in any natural condition, while this is far less the case in the Argynnidi.

It will be seen by this brief review that the clothing of caterpillars is very varied in character, as each of the appendages specified may have an infinite variety of forms and degrees of development. But it will hardly escape notice that if we eliminate from the list all those forms which occur only in caterpillars which still bear the same character which they had in the egg, and which they throw off with their first ecdysis after feeding, the catalogue would be greatly abridged. It may further be noted that there are comparatively few instances in which those forms of dermal appendages which are very general in juvenile caterpillars, and then characterize large groups, appear in any form whatever in later stages of either the same or other groups. The bearing of this point upon the theory of the origin of metamorphosis in insects is evident.

Table of species of Cercyonis, based on the imago.

Ocelli of fore wings enclosed in a common, perfectly distinct, yellow band.....**alope.**
 Ocelli of fore wings enclosed in a very indistinct common pale band or in none at all.....**nephele.**

CERCYONIS ALOPE.—The blue-eyed grayling.

[Blue-eyed ringlet (Gosse); smooth hipparchy (Eminons); alope butterfly (Harris); blue-eyed grayling (Scudder); brown butterfly (Ross); yellow-spotted wood butterfly (Maynard).]

Papilio alope Fabr., Entom. syst., iii: 229 (1793);—Jones, Icon., tab. 12, fig. 1;—Abb., Draw. ins. Ga., Brit. mus., vi: fol. 24, figs. 48-49.

Satyrus alope God., Encycl. méth., ix: 471.

524 (1819);—Boisd.-LeC., Lép. Amer. sept., 228, pl. 59, figs. 1-4 (1833);—Morr., Syn. Lep. N. Amer., 76-77 (1862);—Edw., Proc. Entom. soc., Philad., vi: 195-200 (1866); Can. ent., xii: 24-32 (1880); Butt. N. Amer., ii, Sat. 2

(1882);—French, Rep. ins. Ill., vii: 156 (1878); Butt. east. U. S., 243-248, fig. 71, (1886);—Middl., Rep. ins. Ill., x: 92 (1881);—Fern., Butt. Me., 74-76, figs. 24-25 (1883);—Smith, Bull. Brookl. ent. soc., vi: 127-128 (1884);—Mayn., Butt. N. E., 4, pl. 1, fig. 4, 4a (1886).

Satyrus (Enodia) alope, Westw.-Hew., Gen. diurn. Lep., ii: 392 (1851).

Hipparchia alope Harr., Inj. inj. veg., 3d ed., 305, fig. 127 (1862);—Emm., Agric. N. York, v: 213, pl. 33, figs. 5-7 (1854).

Enodia alope Doubl., Catal. Lep. Brit. mus., i: 136 (1844).

Minots alope Scudd., Syst. rev. Amer. butt., 5 (1872).

Cercyonis alope Scudd., Bull. Buff. soc. nat. sc., ii: 242 (1875); Butt., 115, 131-133, 168, figs. 37, 38, 57, 143 (1881).

Satyrus nephele var. d. *alope* Streck., Cat. Amer. macrolep., 157-158 (1878).

Figured in Abb., Draw. Gray Coll. Bost. soc. nat. hist., 53; also by Glover, Ill. N. A. Lep., pl. 35, figs. 1, 4; pl. A. fig. 23, ined.

These are flowers

Of middle summer.

SHAKESPEARE.—*Winter's Tale*.

Le papillon! fleur sans tige,
Qui voltige,
Que l'on cueille en un réseau;
Dans la nature infinie
Harmonie
Entre la plante et l'oiseau! . . .

DE NERVAL. — *Les Papillons*.

Imago (1:2, 6; 11:8). Head covered with long, erect, gray-brown hairs with many pale dirty ones mingled with them, and behind the eyes with dirty pale scales. Palpi covered with dirty pale and intermingled dull reddish brown scales, especially along the middle of the outer surface, the long, lower fringe made up of dull, rather dark brown hairs externally, internally flanked by many shorter, paler ones, the upper fringe of mingled pale and brownish hairs and scales. Antennae beneath mostly white, above of the color of the upper surface of the wings, interrupted rather narrowly at the base of each joint with white, the last three or four joints of the club and both sides of the whole of the same bare of scales and brownish luteous. Tongue luteo-fuscous, largely luteous at the base; papillae (61:26) about four times as long as broad, subequal, with five or six longitudinal ribs ending in thorns, and with a slender, central, apical filament not so long as the width of the papilla.

Thorax covered above with long, mouse brown and pale reddish brown hairs, frequently, and especially on the patagia, having a pale olivaceous tinge; below with dark gray brown hairs. Legs covered with hairs and scales of a similar color, but paler externally and along the under side of the middle and hind tibiae and tarsi. Spines black; spurs pale luteous, scaled with white at base. Paronychial and basal half of claws very pale luteous, apical half of claws reddish brown, deepening toward tip.

Wings above dark, slightly rufous, brown, with a scarcely perceptible olivaceous tint (♂), or of a similar but paler, rather slaty, brown without any rufous tint (♀). Outer border of fore wings almost perfectly rounded; of hind wings with distinct though slight crenulations. Fore wings with a very broad, transverse, nearly equal patch of pale dull orange (♂), or of paler orange, often verging upon straw-color (♀), extending from the subcostal to the submedian nervures, sometimes surpassing the latter a very little; the exterior margin is generally ill-defined above, better defined and approaching within nearly half an interspace's distance of the outer border; the interior margin is broadly sinuous, passing in a straight or slightly curved line, the concavity outward, above the median nervure at a short distance beyond the apex of the cell; below the upper branch of the median nervure it passes to the submedian in another curve, the convexity inward, the angle between the two curves rounded off at the upper median nervure. In the middle of the upper and lower halves of this broad patch are larger (♀) or smaller (♂), round, black spots faintly and very narrowly edged with umber, each enclosing a pupil of pale blue scales, which is larger in the ♀ than in the ♂, and in the former often white at the centre; the uppermost spot is in the lowest subcostal interspace and in the ♂ occupies just its breadth; in the ♀ it always surpasses this and often extends over the upper half of the subcosto-median and the lower third of the penul-

imate subcostal interspace; the lower is in the lower median interspace, is generally a little, or in the ♀ often considerably, larger than the upper spot, scarcely occupies the whole width of the interspace (♂), or generally encroaches a little and equally on the neighboring interspaces (♀); at about half an interspace's distance from, and parallel to, the outer border is a rather narrow, faint, dusky line which edges the yellow patch on its lower half and in some instances is composed of a series of waves, although usually straight; between it and the upper part of the yellow patch the brown is generally a little paler; extreme outer margin edged faintly with blackish; fringe nearly uniform rather pale slaty brown. *Hind wings* with a small round spot usually present, apparently more frequently in the ♂ than in the ♀, in the middle of the outer two-thirds of the lower median interspace, never occupying more than half its breadth and seldom so much as a third of the same; it is faintly and very narrowly rimmed with ochraceous and minutely pupilled with bluish white; occasionally there is a minute blind black spot in the other median interspace, at a little more than half an interspace's distance from the outer border and nearly parallel to it is a faint, narrow, dusky, slightly wavy line; the outer margin is edged more narrowly with dusky, repeated at a very slight distance inward, the space between being tinged faintly with yellowish; fringe as on fore wings.

Beneath gray-brown, the ♀ a little paler than the ♂. *Fore wings* with the apex somewhat hoary, especially in the ♀, and occasionally tinged slightly with lilac; the basal portion of the wing as far as the broad yellow patch, which is repeated beneath, and especially the discoidal cell, filled with frequent, short, slender, transverse, straight or but slightly curved, interrelated, blackish streaks, and the outer margin of the cell marked narrowly with black; the interior border of the broad yellow band is edged, not very narrowly, with blackish fuscous; the black spots in the lower subcostal and median interspaces are more distinct from being better defined than above, of about the same size as there, the pupil, especially in the ♀, larger and in the latter having a tendency to expand toward the outer limit of the spot; a blackish fuscous stripe bordering the lower portion of the broad yellow patch extends upward nearly to the costal border, subparallel to the outer margin; the outer margin is narrowly edged by blackish fuscous, and is followed at a very short distance by a thread of the same; fringe as on the upper surface, a little paler on the lower half of the wing. *Hind wings* generally having the ground color slightly, sometimes considerably, paler in a broad band occupying most of the outer half of the wing, and, especially toward the costal margin, bounded interiorly by a rather narrow, equal, tortuous, blackish fuscous streak, extending from the costal margin to the submedian nervure; its course is from a very little beyond the middle of the costal margin, over the costo-subcostal and upper subcostal interspaces, transversely in a direction toward the tip of the cell, then in a strong and rather regular curve, convexity outward, to the middle of the lower median interspace near its base (thus passing a little beyond the tip of the cell), and then, resuming very nearly its former direction, it terminates at about the middle of the outer four-fifths of the submedian nervure; within this there is generally an obscure, blackish fuscous, transverse stripe, subparallel to the median one, at a little less than half way from it to the base of the wing; and next, and subparallel to, the outer border at nearly an interspace distance from it is often another discontinuous slenderer one; the whole wing is covered pretty profusely and uniformly with very slender, tremulous, short, slightly curving, blackish fuscous threads, in broken continuity, but having a general direction parallel to the outer border; roundish or suboval black spots, generally edged distinctly, uniformly, and very narrowly with dull orange and minutely pupilled with white, occur, more frequently in the ♂ than in the ♀, in several of the interspaces between the upper subcostal nervule and the submedian nervure; they are generally largest, though seldom more than half the width of an interspace, in the lower subcostal and median interspaces and smallest in the upper median interspace; they are most frequently absent from those in which the spot is normally smallest, and occasionally, in the ♀, they are altogether wanting; when all are present they are situated in a slightly sinuous line; that in the subcosto-median interspace is situated in the middle of the basal half, that in the lower subcostal a little further removed from the outer border; that in the costo-subcostal interspace nearer

the margin, being fully half way from the first divarication of the subcostal to the margin; that in the upper median interspace is slightly before the middle of the interspace; that in the medio-submedian is removed but a interspace's width from the margin; and that in the lower median is on a line, or nearly on a line, with the two last; when only a single ocellus is present it is in the lower median interspace; outer margin narrowly edged with blackish and followed by an equally narrow line of pale brown, followed again by a ground tint darker than usual; fringe slightly darker than that of the front wings.

Abdomen above like the upper surface of the wings; below pale gray brown. Appendages of the male (33:1): upper organ with the hook scarcely tapering and in the middle but little higher than broad: tip bluntly pointed: lateral appendages directed toward the tip of the hook and from one-third to one-fourth of its length, rather bluntly pointed at the tip. Clasps more than one-quarter as broad as long, tapering but little on the basal two-thirds, beyond considerably, by the sloping of the inferior margin and bent slightly upward, the tip rounded off, but slightly produced above; the upper edge of the clasp gently concave with a scarcely perceptible convexity just beyond the middle, beyond which the edge is feeble, armed with a few distant, scarcely perceptible, short, needles.

Measurements in millimetres. Length of tongue, 10.5	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	25.	26.	28.	28.	28.75	29.
antennae.....	11.5		12.25		11.75	12.
hind tibiae and tarsi..	8.	8.25		8.5	8.75	8.
fore tibiae and tarsi..	2.		2.5		2.	1.9

Secondary sexual peculiarities. The androconia are exceedingly slender, taper with perfect regularity and while of the same basal width as in *C. nephele* are proportionally longer, being about .3125 mm. long and .01 mm. broad at base. See also the description of the wings, under the genus.

Egg. Sides furnished with twenty-four or twenty-five longitudinal ribs, forming blunt ridges, at the widest .055 mm. apart, the space between them concave or waved; these ribs extend from the edge of the summit to a little below the broadest part of the egg; they are slightly thickened at frequent and regular intervals, caused in part by one or two minute beads at each of those points, visible only by so strong a lens as will clearly resolve the granulation of the surface, and indicating the passage across them of the delicate transverse lines which otherwise are but faintly visible, and are about .0127 mm. apart; the rim of the summit is formed of an irregular wavy ridge nearly as prominent as the ribs and the secondary circlet is of equal height and irregularity. Micropyle .12 mm. broad. (67:1) broken up by fine lines into cells, the outermost of which are nearly twice as large as the others, the median ones being about .0042 mm. in diameter. Color of egg honey or waxy yellow; afterwards it assumes a pale pinkish line and subsequently becomes irregularly spotted with slightly darker or more distinct, minute, pinkish spots. Height, .94 mm.; greatest breadth, .84 mm.; breadth at rim, .46 mm.

Caterpillar. *First stage* (70:6). Head (78:12) very pale livid yellowish brown; punctulations of the upper portion blackish fuscous; the punctulated area is furnished also with two transverse, slightly curving rows of small, roundish warts of a reddish brown color, four in each row, each wart giving rise to a pretty long, forward curving, brown, spinous hair, the upper row encircling the crown, the lower a little less than midway between the former and the ocelli; also along the dividing line separating the smooth and punctulate portion, there are from five to seven similar minute ones; ocelli fuscous, some of them pale apically, the anterior one malachite green, all at base annulate with black; mouth parts pale yellowish, the mandibles tipped with reddish. Body livid brown with a slender reddish fuscous dorsal line, the sides with three longitudinal, reddish fuscous lines, the upper two approximate; surface delicately, transversely shagreened; legs and prolegs pale yellowish; spiracles luteous. Length,

2.4 mm.; breadth of body, .42 mm.; of head, .52 mm.; length of lateral hairs, .18 mm.; breadth of same, .013 mm.; length of terminal hairs, .28 mm.

Last stage (74:18). Head grass green, uniformly and rather abundantly studded with minute, bluntly conical whitish tubercles, each emitting a moderately long, tapering, pale hair directed slightly downward; mandibles sordid green, black edged, edge of cheeks at base of mandibles dusky; ocelli more or less infuscated. Body above on the thoracic segments of the same green as the head, behind this becoming gradually of a lighter more yellowish green, marked by a narrow, green dorsal stripe indicating the dorsal vessel, which is most distinct and widest on the fifth abdominal and succeeding segments and is almost wholly, if not wholly, lost on the first four abdominal segments; on the sides, below a faintly indicated straw yellow laterodorsal line, the body is again greener, especially in a narrow band next the line, and here again especially on the posterior half of the body. The infrastigmatal fold is marked by a pale yellowish green line, slightly more distinct than the laterodorsal line by being edged above with green, and separating the green pleural area from the greener under surface of the body; entire surface of the body above the legs studded with not very frequent, minute, pale papillae from which spring short, pale, greenish hairs, usually minutely clubbed at the tip, the effect of which is a hoary bloom upon the surface. Terminal horns a little longer than the breadth of the anal prolegs, slightly upturned, a little divergent, and scarcely curved outward, regularly tapering to a rather blunt point, with rather numerous subcylindrical tubercles furnished with hairs like those of the body, the surface of the horns of a ferruginous color, deepest on the upper inner edge, palest at the base on the outer side; legs green, the apical joints pale sordid green; prolegs grass green; spiracles very pale testaceous. Length, 33.5 mm.; breadth of abdomen, 4.5 mm.; of head, 3.25 mm.; length of horns as seen from above, 1.4 mm.

Chrysalis. The whole body is of a uniform pea green mottled with paler green, but the alar ridge, which is sharp and tolerably prominent, the mesothoracic ridge and the ridge between the ocellar prominences are edged with pale straw color. The paler mottlings of the body are upon the dull scabrous elevations with which the body is uniformly covered and which are most conspicuous on the abdomen, giving it a feebly shagreened appearance. The ocellar tubercles and basal wing tubercles are tipped with a black dot. The spiracles are pallid with dingy slender lips. The cremaster is hollowed on all sides and its basal projections are minute and tipped with fuscous. Length, 1.65 mm.; width in middle, 6 mm.; width at ocellar tubercles, 2.5 mm.

Distribution (18:3). This butterfly extends northward to about the annual isotherm of 45°, southward very nearly but apparently not quite to the Gulf of Mexico, and westward to Texas, Missouri (Stolley,—Mus. comp. zool.), eastern and western Kansas (Snow) and Iowa (Allen, Putnam). I have never heard of its being taken in Florida, and all the notices of its capture in the Gulf States have been at some distance from the sea coast. Abbot figures it from Georgia, but says it is uncommon and Gosse records it from Alabama; Mr. Belfrage says it is not common in Texas, while Mr. Allen reports it as exceedingly abundant in Iowa. It is found in Wisconsin (Kirtland), in the southern half of Michigan (Coll. Mich. Univ.), the lower parts of Ontario (Saunders) and throughout most of New York; occasional specimens are taken further north.

It is tolerably abundant, sometimes very common, in the southern half of New England, occurring throughout Massachusetts and the two states lying south of it and in the southern extremities of Maine, New Hampshire and Vermont. The most northern localities from which I have

seen specimens or received notes of its capture, are Norway (Smith) and Portland, Me. (Lyman), Thornton and Shelbourne, N. H. (Faxon) and Sudbury (Scudder) and Stowe, Vt. (Miss Soule). Mr. Jones states that it is also found at Annapolis, and Mr. Fletcher that it has been taken by Downs at Stenacke, Nova Scotia, while Mr. Edwards records it from New Brunswick.

Haunts. It occurs in open woods and orchards, as well as along roadsides and stone walls, especially such as are overgrown with brambles or skirted by shrubbery; also in grassy meadows.

Larval habits and food. In escaping from the egg, the caterpillar bites around the uppermost part of the sides of the shell, throwing off the summit as a sort of lid and generally leaving it attached to the shell by a slender hinge; the egg is then left intact, and the young larva emerges, presenting an odd appearance, with its long, bent hairs directed some forward, others backward.

The food plant is ordinary grass, upon which ripe females will readily lay in confinement. The caterpillar, hatching late in the season, at once descends to the base of the plant on which it is born and hibernates, tasting no vegetable food until the next spring. It is exceedingly lethargic in action and even when full grown moves with exceeding slowness, by almost imperceptible, nervous, forward twitches.

Life-history. In the southern parts of New England the butterfly makes its appearance early in July. Dr. Harris records it in his manuscript as taken July 1, 1831, and I once thought I saw this species at Granby, Mass., on the same day of the month; but it is very seldom seen before the 5th, and in the immediate vicinity of Boston, the 10th or 12th; a few days later, sometimes not until the 17th or 20th, it appears in the more elevated parts of Massachusetts and in southern New Hampshire; it continues to emerge from the chrysalis throughout the whole of July and remains abundant throughout most or all of August and may be taken until the middle of September; the females appear less than a week after the advent of the males, but do not begin to lay eggs* until toward the middle of August,—a long time after their first appearance, and continue depositing until far into September. The earliest that I have myself recorded were obtained by Mr. Emery at Springfield, Mass., from the 22d to the 27th; others were secured by Mr. Minot in the vicinity of Boston, and by Mr. Foster in York, Me., on the 29th; still later ones were sent me by Mr. Whitney from Milford, N. H., on September 6, and I have obtained them at Nantucket as late as September 10. Mr. Mead, however, secured eggs between August 10 and 18 at Martha's Vineyard, and

*This egg was first brought to my notice by Mr. Sprague, who found one laid by the insect upon her own middle tarsus; I have seen a similar instance in our *Speyeria idalia* and in

Oeneis aello of the Swiss Alps; and Mr. Fletcher showed me an *Oeneis jutta* which had managed, in confinement, to lay one upon her own antenna near the base!

Miss Soule some on August 11 at Stowe, Vt. There is then but a single brood each year; that this holds true for the south as well as the north is probable, for specimens sent me from Texas by Mr. Belfrage, were all collected in September, and according to him the females did not begin to lay their eggs until the first of October, or at a period correspondingly near the colder season. Yet there may easily be some error in this, for they have been bred in West Virginia as early as June 9 by Mr. Edwards. The eggs hatch in from twenty to twenty-seven days (twenty-three to twenty-five being the most usual; this is the longest period for hatching known to me among those butterflies which do not hibernate in the egg state)—in the south sometimes in as short a time as fourteen days, so that the caterpillars cannot appear in the northern states until September or the very end of August, too close upon the winter season to enable them to attain any considerable growth in the autumn; and indeed, like the caterpillar of the nearly allied European butterflies, *Minois phaedra* and *Oeneis aello* and many other satyrids, they hibernate without having eaten a morsel of vegetable food. It seems hardly probable that some of the eggs remain unhatched until the spring, for, out of the large number sent me or retained by correspondents, all, excepting the shrivelled, unimpregnated ones, invariably gave birth to the larvae before winter set in. Still their condition would seem to be very similar if they remained in the egg ready to eat their way out. They are slow eaters in the spring, do not usually change to chrysalis before July and after spending about a fortnight in that state appear again as butterflies.

Flight, habits, etc. *Cercyonis alope* has a stronger flight than our other satyrids,—occasionally a prolonged and rapid one, but it may usually be seen tossing itself lazily in and out among the shrubbery at the edge of a wood or by the bushes beside unfrequented roads. Gosse describes it as wary and flying swiftly, “chiefly affecting lanes in the forests, but coming occasionally into the gardens early in the morning.” Allen says it frequents the flowers of *Coreopsis palmata* Nutt. on the prairies of Iowa. Edwards says that multitudes gather on the flowers of the hardhack *Spiraea tomentosa*, which blooms in old fields in July.

At night the butterfly rests upon the branches of low trees or shrubs, probably hanging from the under surface of the twigs. At least this is the conclusion reached by my experience in driving over the Nantucket moors one August day. The wagon track along the broad main road is here lined for a part of the way with a row of low pine trees, with an occasional scrub oak; the wind was blowing across the road; it was about six o'clock in the morning, and not a butterfly was naturally astir, but as we rumbled along the road, hundreds of this butterfly were swept across our track by the wind, forming indeed a continuous stream as long as the fringe of trees continued. Close examination without stopping but kept up for half an hour, showed that they all came from the pine trees; tha

they had risen just as our horse's head was directly opposite them and wafted by the wind across our track, sank drowsily to the earth the other side. The trees were from eight to ten feet high and about twenty feet distant, and no butterflies were seen to leave the trees at any much higher or much lower level than five feet nor any from the ground. They were doubtless started from sleep by the tremor of the ground.

Dr. C. S. Minot notes of the postures of these butterflies that when alighting they rest on the upper surface of leaves; that when walking the legs move alternately, the antennae pulsate in the same way and the wings, held vertically, keep up a quivering motion; the antennae divaricate about 50° while raised at a general angle of about 10° , though this is difficult to determine as the tips droop and the whole curves with an upward convexity; the tips of the fore wings are vertically above the tip of the abdomen. When at rest the outer margins of all the wings are pressed together.

Desiderata. As this butterfly is frequently confounded with *C. nephele* our information is insufficient concerning its northern boundaries in New England; the comparative abundance of the two forms should be noted in every possible locality between the forty-third and forty-fifth parallel of latitude. The determination of its precise relation to *C. nephele* is the most important and the most exacting question to solve. Whether it would be possible to breed the forms in such a way that the parentage may be determined on both sides is yet to be decided. It would seem to be quite possible, for they have been known to pair in captivity (Can. ent. xviii: 17). If it can be done, the relation of the two forms can and should be determined. If not, it will be difficult to bring conclusive evidence; but in any case the experiment should be tried in the belt where both are found. The precise places sought by the young larva in hibernating should be discovered, and the amount of difference—apparently a considerable one for so late a butterfly—in the time of its first appearance in a given locality in different years determined. Some eggs hatch a month earlier than others; is there any advantage or disadvantage in this to the caterpillar that will eat nothing until the next spring? What parasites affect the life of this insect?

LIST OF ILLUSTRATIONS.—*CERCYONIS ALOPE*.

<i>General.</i>		<i>Inago.</i>	
Pl. 18, fig. 3.	Distribution in N. America.	Pl. 1, fig. 2.	Female, both surfaces.
	<i>Egg.</i>	6.	Male, upper surface.
Pl. 67, fig. 1.	Micropyle.	11:8.	Both surfaces.
	<i>Caterpillar.</i>	33:1.	Male abdominal appendages.
Pl. 70, fig. 6.	Caterpillar at birth.	52:4.	Side view, with head and appendages enlarged, and details of the structure of the legs.
74:18.	Full grown caterpillar.	61:26.	Papilla of spiral tongue.
78:12.	Head, first stage.		
18.	Head, third stage.		
86:89.	Dermal appendages of first stage.		

CERCYONIS NEPHELE.—The dull-eyed grayling.

[The dull eyed grayling (Seudder); clouded Hipparchia, cloudy hipparchy, clouded butterfly (Emmons); brown wood butterfly (Maynard).]

Hipparchia nephele Kirb., Faun. bor.-amer., iv:297 (1837);—Emm., Agric. N. York, v:213-214, pl. 33, figs. 3-4 (1854);—Harr., Ins. inj. veg., 3d ed., 306 fig. 130 (1862).

Erebia nephele Westw.-Hewits., Gen. diurn. Lep., ii:380 (1851);—Morr., Syn. Lep. N. Amer., 76 (1862);

Satyrus nephele Edw., Proc. Entom. soc. Philad., vi:195-200 (1866); Can. ent., ix:141-143 (1877); xii:21-32 (1880);—French, Rep. ins. Ill., vii:156 (1878);—Middl., ibid., x:92 (1881);—Coq., ibid., 180 (1881);—

Mayn., Butt. N. E., v, pl. 1, figs. 5, 5a (1886).

Minois nephele Scudd., Syst. rev. Amer. butt., 6 (1872).

Cercyonis nephele Scudd., Bull. Buff. soc. nat. sc., ii:243 (1875).

Satyrus alope (pars) Scudd., Proc. Ess. inst., iii:169 (1863).

Satyrus alope form *nephele* Edw., Butt. N. A., ii, Sat. 3 (1882);—Fern., Butt. Me., 74-76 (1884);—Smith, Bull. Brookl. ent. soc., vi:129-130 (1884);—French, Butt. east. U. S., 243-248 (1886).

I've watched you now a full half hour,
Self poised upon that yellow flower;
And, little Butterfly! indeed
I know not if you sleep or feed.
How motionless! and then
What joy awaits you, when the breeze
Has found you out among the trees,
And calls you forth again!

WORDSWORTH.

Imago (1:1, 4; 11:1). Head covered with long, erect, gray-brown hairs, often paler at their base than at their tip, behind the eye with silvery griseous scales. Palpi covered at the sides with hoary gray or dark, slightly greenish brown scales, the latter below, and usually prevailing; fringed beneath with long, very dark, slightly olivaceous brown hairs, within hoary griseous; above fringed with similar hairs which are paler at their base. Antennae very dark, slightly greenish brown, the joints annulated at the base with white, most broadly below, and the whole upper outer surface more or less tinged with hoary, increasingly so toward the tip, the club being mostly grayish hoary excepting at the tip, where the three last joints, like the whole under surface of the club, vary from dull luteous to yellowish fuscous.

Thorax above covered with long, rather pale mouse brown hairs sometimes slightly tinged with olivaceous, especially on the anterior parts; beneath with shorter, dark, slightly olivaceous, brown hairs. Fore legs covered with similar hairs. In the other legs the femora are covered with silvery gray scales and fringed beneath with mingled dark gray and hoary hairs often tinged with olivaceous. Tibiae and tarsi dusky silvery gray above, silvery white beneath and within. Spines black, spurs luteous, growing reddish toward tip, covered with white scales at base: claws yellowish brown, dusker at tip.

Wings above dark, deep brown with a scarcely perceptible purplish tinge (♂), or of a similar but paler, somewhat slaty or grayish brown (♀). Outer border of fore wings almost straight in the middle half; of hind wings with scarcely perceptible crenulations. In the outer half of the *fore wing*, in the place occupied in *C. alope* by the broad yellow stripe, the wing is tinged or clouded, sometimes scarcely perceptibly, at other times and especially in the ♀ considerably, but generally very slightly, and never to nearly the depth it reaches in *alope*, with yellowish or ochraceous. The limits of the patch are never more than faintly defined and often the wing is simply a little paler in this region, the yellowish tint confined to the encircling of the black spots, which occur as in *alope* in the lowest subcostal and lower median interspaces; they almost invariably are pupilled, either minutely with a white or violaceous white dot (♂), or varying from a minute dot to a conspicuous pupil with bluish or violaceous white, enclosing a white dot or spot (♀); occasionally the lower is blind in the ♂;

the black portion of the upper spot seldom surpasses the width of the interspace in the ♂, and seldom fails of reaching both borders, but in the ♀, it generally extends over fully one-half of the interspace below, and one-third of that above; the lower spot is generally of exactly the same size as the upper in the ♂; in the ♀ it is generally larger and varies from a size equalling the width of its interspace to twice that, encroaching equally above and below; at three-fourths of an interspace's distance from the outer border a faint, dusky, slightly wavy line subparallel to the border is generally present, especially in the ♀; the outer margin is narrowly and faintly edged with blackish and the fringe is nearly uniform dark steel gray, slightly paler at the tips. *Hind wings* with a small round spot, often reduced to a dot, sometimes entirely absent, sometimes as large as the smallest spots of the fore wing of the ♂, and when larger, usually minutely pupilled with white, a little beyond the middle of the lower median interspace; in rare cases a smaller, blind, black spot occurs in the ♂ in the upper median interspace and even in the subcosto-median interspace, a little further from the margin; wing edged and fringed as the fore wing, the fringe a little darker.

Beneath gray-brown, the ♀ a little paler than the ♂, with faint, dark, metallic green reflections. *Fore wings* with the apex somewhat hoary, especially in the ♀, and occasionally tinged with lilac; the basal half of the wing, and to some extent the whole costal border, but especially the discoidal cell, filled with very frequent, short, slender, transverse, straight or but slightly curved, blackish streaks, and the outer margin of the cell sometimes marked narrowly with blackish; at the outer limit of the striped portion is a transverse, sinuous, blackish stripe, similar to that of alope, beyond which the wing is very slightly paler; the two black spots of the upper surface are repeated beneath and with better defined margins, being always conspicuously and equally, though not broadly, encircled with dull orange or yellowish, edged with fuscous, more frequently yellow in the ♀. They are considerably larger than above, in the ♀ larger than in the ♂, subequal, the upper fully as broad as the interspace and encroaching a little on the one beneath in the smaller spots, and in the largest ones, in the ♀, covering more than one-half of the interspaces above and below it; the lower one is almost invariably of exactly the width of the interspace in the ♂, although sometimes including within it also the colored bordering, but in the largest spots in the ♀ crosses one-half of the interspace above and below. They are both pupilled with a white dot, which in the ♀ is encircled with bluish atoms, often extending as a pulverescent cloud toward the exterior margin of the black spot; the outer border of the wing is marked with a submarginal blackish fuscous stripe, subparallel to the outer border but more distant from it above than below, and averaging about an interspace's distance; there is also a slenderer fuscous line next the outer margin, the margin itself is narrowly edged with black and the fringe is slightly darker than on the upper surface. *Hind wings* having generally the ground color slightly, sometimes considerably, paler, in a broad band occupying most of the outer half of the wing and, especially in the ♀ and toward the costal margin, bounded interiorly by a rather narrow, equal, tortuous, blackish fuscous streak, extending from the costal margin to the submedian nervure, and more conspicuous in the ♀ than in the ♂; its course is as in alope; within this there is generally an obscure blackish fuscous stripe as in alope, and distant from the outer margin by an interspace's distance and parallel to it is a subcontinuous, blackish fuscous streak. The whole wing is covered very profusely, more distinctly and heavily and a little more abundantly in passing toward the base, with slender, tremulous, short, subconnected, slightly curving, blackish fuscous threads, parallel to the outer margin; longitudinally suboval or roundish, small, black spots edged narrowly, and more or less distinctly, especially in the ♂, with dull umber orange, and usually pupilled with a white dot, occur, much more abundantly in the ♂ than in the ♀, in one or all of the interspaces between the upper subcostal nervule and the submedian nervure. In the ♂ they generally occur in all the interspaces; in the ♀ they are generally present in the lower subcostal and lower median interspaces; that in the lower subcostal interspace is usually oval, the others usually round; they are largest in the lower subcostal and lower median interspaces,

usually next in size in the subcosto-median, and in the others subequal; they are arranged in a sinuous curve corresponding exactly with their disposition in alope; outer margin narrowly edged with blackish and followed by an equally slender thread of pale brown, succeeded by a darker tint than usual; fringe similar to that of the fore wings.

Abdomen above and on sides of the color of the upper surface of the wings; below ash gray. Appendages: upper organ with the hook as in the preceding species, but rather slenderer, especially toward the base, slightly longer and scarcely more arcuate; lateral arms directed toward the middle of the hook, turned strongly inward, about one-fourth the length of the hook, rather bluntly pointed at the tip. Clasps about three and a half times longer than broad, ensiform, tapering pretty regularly from base to tip, the basal half curving a little upward, the apical half straight, the tip bluntly pointed; apart from the hairs with which it is clothed, the upper surface appears to be unarmed.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	23.75	25.5	28.	26.75	29.5	31.
antennae.....	10.75	11.	12.	10.5	12.2	12.2
hind tibiae and tarsi.	8.	8.25	8.75	8.	9.25	9.75
fore tibiae and tarsi.	1.75	1.75	2.	1.85	2.5	2.5

Secondary sexual peculiarities. The androconia taper with nearly perfect regularity, but a little more perceptibly near the middle of the distal half, and while of the same basal width as in *C. alope*, are proportionally shorter, being about .25 mm. long and .01 mm. broad at base. See also description of fore wing, under genus.

Egg (64:3). "About eighteen vertical ridges, with rounded excavations between, spring from the lower part of the side and run to the edge of the top; this last is rounded and covered with shallow cells, irregularly hexagonal around the outside, and in the middle long and narrow, about an oval central cell." (Edwards.)

Caterpillar. *First stage.* Head light yellow brown, specked with brown and sparsely pilose, sometimes with cloudy brown patches on upper part of face. Body carnation, with a dorsal crimson line, and three similar closely approximated lines on each side of the body; appendages white. Length, 2.5 mm. (after Edwards).

Second stage. Head light green, with white papillae in vertical rows, each with a white hair. Body pale green, with dark green longitudinal stripes occupying the position of the crimson lines of preceding stage; extremity of caudal horns red; papillae white, each supporting a blunt white hair. Length, 4 mm. (after Edwards).

Third stage. Head nearly as before. Body with the whole surface one shade of yellow green, except a dark dorsal stripe, and a yellow infrastigmatal ridge. Length, 7.5 mm. (after Edwards).

Fourth stage. Head emerald green, covered with conical white papillae. Body nearly as in preceding stage. Length, 11 mm. (after Edwards).

Last stage. Head emerald green, the surface covered with slightly paler, conical papillae and pubescent. Body dull yellow green, the sides a shade darker than the dorsal area, with a dorsal dark green stripe, and an infrastigmatal yellow stripe or line, the caudal horns reddish; surface of body covered with fine white papillae, each bearing a fine white hair, rendering the surface pubescent. Length, 30 mm.; breadth, 4 mm. (after Edwards).

Chrysalis (83:7, 8). "Whole surface one shade of yellow green, covered with minute white granulations; along the inner margins of the wing cases a cream white line, another along keel of mesonotum, and one across top of head case" (Edwards). Length, 15 mm.; breadth, 5 mm.

Distribution (18:4). This butterfly is a northern representative of *C. alope*, meeting it on common ground somewhere between the annual iso-

therms of 45° and 50° ; it extends westward certainly as far as the foot-hills of the Rocky Mountains, where it has been taken north of our boundary by Geddes, in the Judith and Big Horn Mountains by Morrison, in Colorado by Mead, Osten Sacken, Snow and myself, and in New Mexico by Snow. It is most abundant on the western prairies of Iowa, Wisconsin and northern Illinois, and is found also in Kansas (Snow), Nebraska (Carpenter), Michigan (Harrington) and eastward, north of about 42° N. Lat. Mr. Saunders reports it "rare" at London, but "common" at St. Catharines, Ontario; Edwards says it occurs in northern Ohio; specimens have been sent by Mr. Howell from Nichols in southern New York; Mr. Lintner has taken it at Bethlehem, Sharon Springs and Schoharie in the same state, and it is common in the Catskills; its northern limits are wholly unknown, reaching, perhaps, beyond the spread of settlement. Its northernmost known occurrence is in the Athabasca region (Geffcken). Mr. Couper does not report it from the northern St. Lawrence, but it is taken at Quebec (Bowles), River Rouge district (D'Urban) and Ottawa (Billings, Fletcher), and is abundant near Annapolis in Nova Scotia (Jones).

It is found over the whole northern half of New England in great abundance; the only locality in which I have met with it in Massachusetts is the elevated region about Williamstown, but it undoubtedly approaches closely to the northern limits of the state, and is found throughout Maine.

Life history, etc. It is found in open woods and frequents the thistle in pasture ground near the edge of woods. In northern New England, the butterfly usually makes its appearance a little before the middle of July. Miss Wadsworth tells me that it has appeared at Hallowell, Me., on July 12 for three successive years. Mr. Fletcher, however, has taken it as early as June 28 at Ottawa, Canada; in the west also it is earlier than in New England; but in the deeper valleys of the White Mountains it sometimes fails to make its appearance until nearly a month later. It does not continue quite so long on the wing as *C. alope*, at least in New England, but generally disappears in August. It is single brooded. Mr. Edwards has described its earlier stages; the butterfly has been taken pairing with *C. alope* and closely resembles this species in the time of its appearance. The eggs are laid on grass in the latter part of August, many being dropped loosely on the ground by females in confinement; the eggs hatch in a month's time and, as with *C. alope*, the caterpillars go at once into hibernation. After hibernation "the coloration in all the stages . . . is that of the grass the larva feeds on, or very nearly, and the larvae, although so slow in their motions, fall from the stems at the least alarm; so that they are sufficiently protected in their natural state against most enemies." (Edwards.)

Flight and posture. The flight of this species is altogether like that

of *C. alope*. In repose in the sun, Dr. C. S. Minot has found that the abdomen inclines downward so that the tip rests on the surface of support; the antennae divaricate about 100° and have a general upward inclination of about 10° ; the wings are brought together over the back, so that the apex of the fore wings is vertically over the middle of the thorax. The femur of the middle legs is directed upward, outward and forward; the tibia outward, forward and downward, and the tarsi the same but more nearly horizontal.

Desiderata. Compare in the first instance the desiderata of the preceding species, which are bound up with this. As there, the parasites are unknown, and the boundaries of its extension over the continent have to be determined with far more care than is yet possible.

LIST OF ILLUSTRATIONS.—*CERCYONIS NEPHELE*.

<i>General.</i>		<i>Imago.</i>	
Pl. 18, fig. 4.	Distribution in N. America.	Pl. 1, fig. 1.	Female, both surfaces.
<i>Egg.</i>		4.	Male, upper surface.
Pl. 64, fig. 3.	Plain.	11:1.	Both surfaces.
<i>Chrysalis.</i>		38:1.	Neuration.
Pl. 83, fig. 7.	Side view.	46:3.	Androconium.
8.	Dorsal view.		

SECTION II.

Egg nearly smooth, but reticulate, with no vertical ribs. *Caterpillar at birth* with straight cuticular appendages, and the summit of the head surmounted by a rounded projection. *Mature caterpillar* slender and elongated, with the head much larger than the segments immediately behind, and crowned with pointed tubercles. *Chrysalis* with an angularly rounded mesonotum, and a protuberant head. *Imago* with extremity of cell of fore wing nearly transverse; base of middle median nervule identical with that of the outer nervule, or much nearer to it than to the inner nervule.

GENERA: **Enodia**, **Satyrodes**, **Neonympha**, **Cissia**.

ENODIA HÜBNER.

Enodia Hübn. Verz. bek. schmett., 61 (1816).

Type,—*Oreas marmorata andromacha* Hübn.

A brave old house! a garden full of bees,
Large dropping poppies, and queen hollyhocks
With butterflies for crowns—free peonies
And pinks and goldilocks.

INGELOW.—*Honors*.

Imago (52:5). Head of moderate size, pretty uniformly tufted with moderately long hairs; front full, curving on every side, broadly protuberant in the middle below, narrower than the eye, a little higher than broad, terminating above at the base of the antennae rather squarely; lower edge rather abrupt, broadly rounded; vertex very transverse, very slightly protuberant, the posterior edge very slightly convex, the anterior straight; upper border of the eye with a scarcely perceptible angulation opposite the posterior base of the antennae. Eyes pretty large, moderately full, pilose with short and very delicate hairs. Antennae inserted in the middle of the head, or possibly just behind the middle, in a broad not very deep pit just large enough for their recep-

tion, disconnecting the front and occiput, their bases meeting each other on one side and the edges of the flanks on the other: a very little longer than the abdomen, composed of forty-two or forty-three joints, increasing a little and very gradually in size on the apical fourth, the last three or four joints diminishing again, terminating in an abrupt cone, the club being more distinct than in *Oeneis* or in *Cercyonis*: transversely circular, the club a little depressed and furnished beneath with a scarcely perceptible median furrow, edged by slight carinations. Palpi slender, scarcely twice as long as the eye, compressed, the apical joint one quarter as long as the preceding; excepting the apical joint profusely tufted beneath with long, above with short, hairs, all compacted in a vertical plane.

Prothoracic lobes very small and delicate, beneath appressed to a mere pellicle, above suddenly expanding into a transverse, cylindrical, bulbous mass, somewhat reniform when viewed from the front, but otherwise nearly equal, the ends well rounded, the swollen portion nearly as long as high and three times as broad as high. Patagia but little convex, with the posterior lobe more than twice as long as broad, tapering rapidly on the basal half, then but slightly to the rapidly tapering rather blunt point.

Fore wings (88:6) considerably produced at the apex; costal border almost straight near the base, the outer two-thirds very regularly but not greatly arched; outer border slightly convex in the upper half, straight below; inner border straight, the lower outer angle rounded off a little, bent at rather more than a right angle. Costal nervure slightly swollen at the base to a distance equal to the width of the cell; first two superior branches of the subcostal nervure arising close to the tip of the cell, the latter a very little less than half as long as the wing and about two and a half times as long as broad; median and submedian nervures not enlarged at base.

Hind wings with the costal margin pretty strongly convex but with the middle half a little depressed; outer border slightly crenulate and slightly angulate at the upper median nervure, the upper half being scarcely concave, the lower scarcely convex, at the lowest retreating rapidly to the inner border; inner margin a very little curved, the lower outer angle broad. The nervure closing the cell strikes the median nervure a little before its final divarication, and the subcostal at the termination of the basal curve of its last branch; first median nervure originating opposite the middle of the basal curve of the last subcostal nervure.

Fore legs very small, cylindrical, the tibiae nearly one-third the length of the hind tibiae; tarsi of the same length as the tibiae, either composed of two joints, the apical hardly one-fourth the length of the basal, and apically tapering to a prong-like point (δ), or, consisting of five joints, of which the first is twice as long as all the others together, the rest nearly equal, all but the terminal furnished beneath at the tip with a very short and slender, scarcely tapering spine (φ): leg otherwise wholly unarmed excepting by long and delicate hairs, expanding laterally and directed forward, much more abundant in the δ than in the φ ; middle tibiae five-sixths the length of the hind tibiae, both furnished on either side of the under surface with a row of scarcely erect, forward directed, slender and short, infrequent spines, the apical ones forming very long and slender spurs; tarsi having the first joint fully half as long as the whole tarsus, the second, third and fourth decreasing slightly in length in the order mentioned, the fifth equal to the second; their whole under surface covered profusely with long and slender spines; claws strongly and regularly curved, slender, compressed, delicately pointed; pulvillus quite small, broader than long, almost semi-circular; paronychiae composed of two members: an upper, shaped and curved like the claws and of the same length; and a lower, forming an equally slender but short, incurved strap, both delicately fringed.

Male abdominal appendages: upper organ rather stout, but compressed, the centrum slightly arched above, rapidly narrowing at the base of the hook, which is nearly straight, bent strongly downward, greatly and equally compressed, as long as the body, pointed at the tip: sides of the body furnished at their upper limit with a single slender, tapering, compressed, laterally arcuate, backward directed appendage, nearly as long as the hook. Clasps very long and very slender, being longer than the upper organ and scarcely more than one-sixth as broad as long, narrowing gradually in the mid-

dle half, beyond equal and not one-quarter the width of the base, nearly straight when viewed laterally, the extremities curved toward each other when viewed from above, the extremity blunt, but armed.

Egg. Flattened spheroidal, the base rather broadly truncate, so that the width is about a fifth greater than the height, and the base about two-thirds the entire width. Surface smooth.

Caterpillar at birth. Head large and full, broader than the body, broader below than above, subtruncate above, each hemisphere with a slight conical elevation above, emitting a long hair; front with ranged hairs. Body nearly uniform, tapering in the posterior half, the last segment broadly and briefly furcate, the segments furnished with long, club-tipped hairs, arising from papillae arranged as follows on the abdominal segments, one to a segment in each row: a latero-dorsal series, anterior; a supra-lateral series, posterior; an infralateral series, central; and an infrastigmatal series, central and posterior, there being here a pair; the hairs on the thoracic segments vary a little from this. (After Edwards.)

Mature caterpillar. Head uniformly deep, the anterior summit of either half produced upward and very slightly forward into a conical horn nearly as high as the depth of the head. Apart from the horns the head is of equal height and breadth, nearly as broad as the broadest part of the body, much broader below than above, broadest at summit of ocelli; frontal triangle nearly twice as high as broad, reaching more than half way to the vertex, the sides straight. Surface regular, sparsely punctate, and furnished besides with rather numerous and irregularly distributed, conico-cylindrical, blunt tipped, erect papillae, higher than broad, each emitting a very short hair, those on the horns directed obliquely upwards. Antennae small; first joint mammiform; second short, cylindrical, half as long as broad; third scarcely slenderer, cylindrical, twice as long as broad, emitting a long, curved hair. Ocelli much as in *Satyrodes*.

Body long and rather slender, broadest near the middle, tapering posteriorly much more than anteriorly, otherwise nearly cylindrical with no infrastigmatal fold; terminal segment with a pair of horns similar to those of the head but longitudinal, much longer, regularly conical and pointed, their outer surfaces parallel. Each segment divided by five transverse incisions into sections, which are equal on the thoracic, unequal on the abdominal segments, one incision being scarcely in advance of the middle, one above the spiracles, and the others dividing the posterior half into equal divisions. Body covered abundantly and pretty uniformly with exceedingly small, conical papillae, from each of which arises a very short, tapering, pointed, erect, but generally curving hair, several times longer than the papilla. Legs very short, conical, the interior edge of each joint with long bristles; claw minutely curved. Prolegs very short indeed and plump, the last joint strongly bristled externally.

This genus is confined to eastern North America, where it is represented by a single species, — the one described below. Westwood and Hewitson classed it with certain East Indian forms, in the genus *Debis*; and it is certainly more closely related to them than to any North American satyrids, though clearly distinct from them. It is exceedingly rare in New England.

The wings of the butterfly are more elongated and less ample than in *Cercyonis*; they are warm, lustrous brown above, paler below, especially outwardly, with a submarginal series of rather numerous, unequal, dark, blind spots with a pale edge; beneath, these spots are repeated, but are ocellated and encircled by a common pale ring; the middle of the wing is crossed beneath by a pair of distant, slender, dark stripes, the inner nearly

straight, the outer irregular and also indicated above on the fore wings. In the structure of the head this genus approaches *Oeneis* rather than *Ceryonis*; from the latter it is clearly distinct in the shape of the front, the pilosity of the eyes and the want of erect tufts of hairs on the apical palpal joint.

There is but a single brood each year, the butterflies appearing before midsummer. The egg is spheroidal and smooth. The head of the larva is crowned with a pair of long, conical horns, and the last segment of the abdomen is furnished with similar projections; the body is pale, with longitudinal stripes of dark green. The chrysalis is well rounded, with a bluntly arched head and a well curved abdomen, terminating in a long, slender cremaster, by which it is suspended.

A fossil butterfly belonging to a closely allied extinct genus has been found in the tertiaries of southern France.

EXCURSUS III.—THE GENERAL CHANGES IN A BUTTERFLY'S LIFE AND FORM.

Who that beholds the summer's glistening swarms,
Ten thousand thousand gaily gilded forms,
In volent dance of mix'd rotation play,
Bask in the beam, and beautify the day;
Who'd think these airy wantons so adorn,
Were late his vile antipathy and scorn,
Prone to the dust, or reptile thro' the mire,
And ever thence unlikely to aspire?
Or who with transient view, beholding, loaths
Those crawling sects, whom vilest semblance cloaths;
Who, with corruption, hold their kindred state,
As by contempt, or negligence of fate;
Could think, that such, revers'd by wondrous doom,
Sublimar powers and brighter forms assume;
From death, their future happier life derive,
And tho' apparently entomb'd, revive;
Chang'd, thro' amazing transmigration rise,
And wing the regions of unwonted skies;
So late depress'd, contemptible on earth,
Now elevate to heaven by second birth?

HENRY BROOKE.—*Universal Beauty*.

MORE than fifty years ago, that prince of dreamers, Oken, wrote: "The insect passes through three stages prior to its attaining the adult or perfect condition. It is at first Worm, next Crab, then a perfect volent animal with limbs, a Fly."

A sagacious observation, of which full use was made by Agassiz in comparing its ontologic and phylogenic development. In external form the caterpillar so closely resembles a worm that in common language it is often so called; it is a long cylindrical object with many legs by which it drags its whole length upon the ground; its body consists of a series of rings placed end to end; its head, it is true, is more or less separated from the rest of the body, but yet agrees so well in general size and form with the segments behind that the distinction often only appears upon examination;

while the difference between the joints forming the future thorax and those of the abdomen can only be traced by careful study.

This explains the voracity of the caterpillar, and shows that the main end of its existence is to gormandize and grow; examining its interior, we find that the muscles occupy hardly more space than twice the thickness of the skin to which they are attached; and their very object is to move the creature to a feeding spot or remove the old integument to admit of a larger growth and a greater capacity for food; those of the head are almost exclusively attached to the jaws. The general cavity of the body is mostly occupied by the alimentary canal and its appendages, the glands and nerves and even the tracheae really requiring an insignificant amount of space; and whatever is not occupied by these organs, necessary to the assimilation of food, is choked up with the fatty masses embedded in the cellular tissue.

It is impossible, however, that it should grow to any extent without finding its outer integument, and especially the dense covering of the head, much too small for its needs, since its bulk at maturity is a hundred times or more that at its birth. Nature provides for this emergency, for the caterpillar does not grow insensibly like most animals, but, as in other insects by distinct stages; for when the skin has become too contracted for its needs it rests awhile, and then suddenly the skin bursts, and the creature, in new array, which had been forming beneath the old coat, crawls forth to new and more vigorous activity, until similar difficulties are again encountered. During the resting spell, the interior head is withdrawn from the old case to the first thoracic segment, which, during the moulting period, is abnormally distended; and it is here that the bursting of the old skin takes place, the head being separated from the body, and the old skin being gradually shoved off behind, together with the lining of the larger parts of all internal organs having considerable external openings. The number of such moults varies, but never exceeds six.

When it assumes the pupal stage its habits change completely, it being now quiescent, with no power of eating or of any movement beyond a shake or a wriggle; and its form compacted, with all the appendages soldered firmly to it; although the line of separation between thorax and abdomen is well marked, and the latter is composed of many joints movable one upon another, nearly all special distinction between the head and thorax is lost, and their segments are immovably soldered into one common tract. This is an exact temporary repetition of the more important distinctive external features of the crab and lobster, where the head and thorax are united by a common shield into a cephalothorax, while the joints of the abdomen are freely movable. This, then, is what Oken meant when he pointedly calls the pupa, Crab.

The closer we examine this "crab," the better we see how admirably the form and projections, the position and inactivity of the chrysalis are

adapted to its purpose. Great changes are to transpire in the hidden recesses of the body; the outer integument is a compact, hardened case, protected at every needed point by roughened projections or callous shoulders; all the appendages are securely ensheathed and so cemented to the outer integument as to form part and parcel of it, without disturbing its contours; all unnecessary openings are firmly closed, and those that remain are carefully guarded by dense callous spots; and in addition hooked claws, attached to the thickened tail, fasten the swinging mummy securely in its place.

From this inert mass shall suddenly spring, like well-clad Minerva from the head of Jove, a creature of no apparent kinship either with the case that enwrapped it or the lowly worm that preceded the chrysalis; a creature with soft, elastic body, buoyant as the air in which it floats, with spreading feelers and broad-spanned wings, clothed with jewelled dust and silken hair which reflect the colors of the rainbow, and in their delicate combinations defy the painter's palette. But how did such a creature, whose plumage is ruffled by a breath of wind, escape from its iron prison, hardened by months of exposure to wintry cold and sleet and sun in rapid succession? There is a weak point in every structure, and in the chrysalis it lies next the point of greatest strength in the captive butterfly. The butterfly never emerges in winter, but when the more genial showers of spring or the damp air of a summer's night have softened the texture of its prison-walls, they are further weakened by the moisture now exuded by the twice-bound prisoner, feeling the hour of final release draw near. A suture along the crest of the thorax gives way, often with a perceptible click, to the force of the great muscular mass within; the rest is easy; the rent is continued on both sides down other sutures, until a door is open, whose smooth inner walls suffer no harm to the delicate creature struggling to escape. Slowly the limbs are withdrawn from their encasements, cautiously the butterfly climbs the friendly twig that has been its support, and sitting in the sunshine dries its moist quivering wings, gently fanning them up and down, until, full of new life and courage, it ventures forth — a thing of beauty and a joy forever.

ENODIA PORTLANDIA.—The pearly eye.

[The pearly eye (Gosse); pearly wood butterfly (Maynard).]

Papilio portlandia Fabr., Spec. ins., ii:82 (1781); —Abb., Draw. ins. Ga., Brit. mus., vi:34, figs. 50-51.

Satyrus portlandia Boisd.-LeC., Lép. Amer. sept., 226-227: pl. 58, figs. 1-5 (1833).

Debis portlandia Westw.-Hew., Gen.

diurn. Lep., ii:360 (1851); —Morr., Syn. Lep. N. Amer., 79 (1862); —Middl., Rep. ins. Ill., x:92 (1881); —Edw., Can. ent., xiv:84-88 (1882); Butt. N. Am., iii, pl. Debis 1 (1888); —Fern., Butt. Me., 72-74 (1883); —French, Butt. east. U. S., 229-232, fig. 70 (1886); —

Mayn., Butt. N. E., 3, pl. 1, figs. 3, 3a (1886).

Lethe portlandia Butl., Catal. Satyr. Brit. mus., 114 (1868).

Euptychia portlandia Kirb., Syn. catal. Lep., 55 (1871).

Enodia portlandia Scudd., Syst. rev. Amer. butt., 5 (1872).

Papilio fuscus, etc. Pet., Gazoph., i: 4, pl. 33, fig. 11 (1709).

Oreas marmorata andromacha Hübn., Exot. schmett., i, Lep., 1, Pap., 1, Nymph., viii, Oreades, C. marm., a., figs. 1-2 (1806).

Enodia andromacha Hübn., Verz. bek. schmett., 61 (1816).

Hipparchia andromacha Say, Amer. entom., ii, pl. 36 (1825); Entom. N. Amer., ed. LeC., i: 81, pl. 36 (1859); —Gosse, Can. nat. 246, fig. (1860).

Debis andromacha Morr., Syn. Lep. N. Amer., 78-79 (1862).

Enodia androcardia Hübn., Ind. ex. Lep., 1 (1821).

Figured by Glover. Ill. N. A. Lep., pl. 37, fig. 4; pl. A, fig. 22, ined.

When butterflies flutter from clover to thicket,
Or wave their wings on the drooping leaf.

GILDER.—*A Song of Early Autumn.*

When you do dance, I wish you
A wave o' the sea, that you might ever do
Nothing but that.

SHAKESPEARE.—*Winter's Tale.*

Imago (1:3). Head covered with olivaceous brown hairs mingled with many pale and whitish ones especially about the base of the antennae; immediately behind the eyes many whitish scales, backed above by greenish brown ones. Palpi externally white, mingled below with a few pinkish scales on the middle joint, fringed on the first joint with white hairs, on the middle joint with long blackish brown hairs externally, white internally; second joint fringed above near the tip with short, dusty brown hairs, the last joint brownish, with a middle line of white interiorly and exteriorly. Antennae blackish brown, yellowish luteous below, rather broadly annulate, excepting beneath, at the base of each joint with white; toward the club the yellow, luteous or honey yellow of the under surface expands, so that the whole club is yellow, excepting the basal half of the upper surface and a blackish fuliginous belt including the whole of the fourth to the seventh joints from the tip.

Thorax covered above anteriorly with soft greenish yellow and brownish hairs, behind with brownish tinged with sea-green, below with very pale brownish yellow hairs. Fore legs dusky, covered with hairs like the under surface. Other legs with the femora silvery gray, tinged toward the tip and externally to a greater or less extent with rather lustrous pale brownish yellow; beneath delicately tufted with whitish; tibiae mostly pale brownish yellow, specked delicately with brown; tarsi above a little darker; spines pale brownish yellow; spurs clothed mostly with pale brownish scales, the tip reddish, claws reddish; generally a little fuscous.

Wings above soft clay brown, the ♀ perhaps slightly paler. *Fore wings* deepening in tint just beyond the middle of the wing, so as to form an irregular, transverse, dusky band, its exterior border rather vaguely defined, its interior gradually fading into the ground tint, usually more distinct on the upper than the lower half of the wing, running from the costal border to the upper median nervule in a nearly straight line, parallel to the outer border of the cell (which is generally marked by a dusky thread) and distant from it by the width of the cell at the tip, reaching the upper median nervule a little before its middle; generally it is suddenly expanded in the subeostomedian interspace, by being carried outward an interspace's distance; from the upper to the lower median nervule it passes in a strong curve, its concavity outward, reaching the latter a little beyond the middle; below this it continues its previous course in a nearly straight line; a little beyond the middle of the outer half of the wing is a transverse straight series, subparallel to the outer border, of four or occasionally five roundish or suboval blackish spots, one each in the lower median and the interspaces above, the uppermost usually wanting; that in the upper median interspace is slightly beyond the middle of the interspace; they are usually pretty well defined but sometimes blurred, and are surrounded with a slender, equal, dull yellowish, not very distinct annulus; the lowermost is largest, longitudinally suboval, and with its annulus fills or very nearly fills its interspace; that in the upper median interspace is next in

size, nearly round and a little smaller; that in the lower subcostal, again a little smaller, with its border fills the interspace and is round or nearly so; that in the subcosto-median is again smaller and is sometimes reduced to a mere dot with a halo around it; the uppermost never becomes more than this and sometimes is reduced to a pale dot; directly above these, in two of the narrow subcostal interspaces are pale vague spots and, excepting on either side of them, all the space between the irregular mesial stripe and the darker margin of the outer border is a little paler than the basal half of the wing, with a slight yellowish suffusion; it is palest just outside of the mesial stripe and especially in rather a broad patch in the subcostal and costal area; there is a narrow dark margin less than half an interspace in width next the outer border, often with a paler thread running through it and followed, at an interspace's distance from the margin, by an obscure dusky stripe; fringe pale, interrupted with basal broad dusky waves, occupying one-third of the base in the interspaces and more than two-thirds at the nervure tips. *Hind wings* with a faint dusky thread closing the cell and an almost equally faint, narrow, dusky, transverse stripe just beyond it, running from the upper subcostal nervule at one-fourth the distance from its base in a broad curve, its concavity outward to the upper median nervule, at about the same distance from its origin; it then turns at right angles toward the inner border and is lost before crossing the median interspaces; in the outer half of the wing there is a transverse, strongly curving, regular series of five very large roundish blackish spots, encircled with pale dull yellow in the subcostal, subcosto-median and median interspaces, subparallel to the outer border; those in the subcostal interspaces are equal and much larger than the others, the black portion alone occupying the width of the interspace and often surpassing it slightly at the lower edge; the upper is in the middle and the lower in the middle of the outer two-thirds of its interspace; those in the median interspaces are subequal, the upper a little the larger, longitudinally suboval and, with their encirclement, scarcely equalling, especially in the lower median, the width of the interspaces in which they occur; the upper is a little beyond the middle of its interspace and the lower is at a slightly less distance from the outer border; that in the subcosto-median is smallest, equalling, with its halo, the interspace and is a little nearer the outer border than any others; the yellowish margin to the two and sometimes the three upper spots is often blended to a greater or less degree; the outer margin is narrowly edged with dusky, followed at a very short distance by a dusky thread and that at a similar distance by a broader yet slender stripe of dusky, the inner border of which is generally indistinguishable; fringe as on the fore wings.

Beneath pale gray-brown, with pale pearly violaceous reflections. *Fore wings* with a slender, transverse, curving, blackish fuscous stripe crossing the whole wing, its outer edge striking the first divarication of the median nervure; the outer limits of the cell are marked narrowly with dusky and beyond it is an irregular, slender, transverse, blackish fuscous stripe, crossing the whole wing as far as the submedian nervure, its outer limit well defined, its inner much less so, and between it and the tip of the cell, the subcostal nervules marked with dusky; its outer border passes from the costal border to the lower portion of the subcosto-median interspace in a nearly straight line, often bent outwards a very little at either end, parallel to the outer limit of the cell and distant from it by its own width at tip, reaching its outermost limit at about one-third the distance from the base of the interspace to the wing border; from here it passes in a pretty regular, and rather deep curve, the concavity outwards, to the lower median nervule a very little beyond its middle, and thence passes in nearly a continuous course to the submedian; it is immediately followed exteriorly by a pale or whitish field, broader than itself but quickly merging into the ground color, and suffused with lilac or violaceous; beyond the middle of the outer half of the wing is a nearly straight, but slightly curving row of four or five black ocelli, the concavity outwards, subparallel to the outer border, in the lowest subcostal, subcosto-median, median, and sometimes the medio-submedian interspaces; they are encircled not very narrowly with pale yellowish and the larger ones usually pupilled with a white dot; they are barely enclosed in a common, faint, dusky field, surrounded faintly and not broadly

with a pale lilac corona; the spot in the medio-submedian, when it occurs, is minute; that in the lower median is largest and roundish or longitudinally oval, and with its bordering fully fills the width of the interspace; that in the upper median is next in size but does not fill the interspace; that in the lower subcostal follows and the one in the subcosto-median is not more than one-half the width of the interspace; the inner edge of the spot in the upper median is at the middle of its interspace. The outer margin is edged narrowly with blackish and is followed very closely by a slender, equal stripe of ochraceous edged with dusky, parallel to the outer border and extending from the terminal branch of the subcostal to the submedian; it is followed by a pale, rather faint, lilac stripe of about equal width. Fringe much as above, but with the darker colors prevailing and a little enlivened with yellowish brown. *Hind wings* similarly marked; a transverse, nearly straight, blackish fuscous, slender stripe across the middle of the basal half of the wing, often broken a little at the median nervure, crosses the subcostal and median nervures near the middle of the outer half of the portion before the divarication; the outer limit of the cell is marked by a distinct, dusky line; and beyond it is an extra-mesial, irregular, transverse, rather narrow, dark brown stripe, starting from a little beyond the middle of the costal border and passing in a pretty strong and regular curve, opening outward, to the middle of the subcosto-median interspace in the middle of its basal four-fifths; thence it turns inward again, passing in a somewhat irregular manner, but with its general course in a similar, though rather shallower curve, to the submedian at about an interspace's distance from the border; excepting in the subcosto-median and upper median interspaces this stripe is subparallel to the intra-mesial one; its outer limit is the best defined; outer half of the wing with a series of six longitudinally suboval, sometimes roundish, well defined, black spots, often besprinkled lightly with dark yellowish, rimmed narrowly, but distinctly, with dark yellowish and generally pupilled with a bluish white dot; the uppermost is in the upper subcostal interspace, largest, nearly round, occupying with its rim the whole width of the interspace and situated rather before its middle; the others form a pretty regular curve, subparallel to the outer border, and are subequal in size, that in the lower median being usually largest, that in the medio-submedian double and with two pupils, sometimes separated by a yellowish margin, and that in the subcosto-median smallest, and usually round, while the others are usually suboval; that in the upper median is situated a little beyond its middle; the uppermost by itself, and the others in common are enveloped in a faintly purplish brown cloud, which is again bordered by a rather faint, subdued bluish or lilac, pale band merging into a pretty large spot between the subcostal ocelli; the outer margin and fringe are as in the forewings.

Abdomen above blackish brown, with brownish yellow, intermingled scales; beneath pale, silvery gray. Male appendages (33:3): upper organ constricted a little at the extreme base of the hook, the latter bent downward at an angle of about forty-five degrees, its upper edge straight or even slightly concave until close to the tip, which is curved slightly downward; the lower surface is somewhat arcuate in an opposite sense and considerably excised just before the tip, so as to increase the curve at the tip; the hook is about as long as the centrum and four times as long as broad; lateral arms directed straight backwards, curving slightly toward each other, tapering regularly to a fine point and more than half as long as the hook. Clasps narrowing rapidly for a short distance by the excision of the upper border next the base, and bearing at the upper, inner extremity of their tips a single, small, conical, inward directed tooth, which appears simply as the continuation of the blade.

Measurements in millimeters.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 6.5						
Length of wings.....	25.	27.5	29.5	27.5		29.
antennae	11.	11.85		11.5		
hind tibiae and tarsi..	7.25	7.9	8.25	7.9		8.25
fore tibiae and tarsi..	2.65	3.	3.	3.		3.25

Egg (64:4). Pure white, the surface highly glistening, smooth, with no trace of any cellular structure, the height about a fifth less than the breadth. Diameter, 1.1 mm; height, 0.92 mm.

Caterpillar. *First stage* (70:9). Head (78:17) yellow, somewhat brown tinted, afterwards changing to yellow green, the surface corrugated. Body whitish yellow, in a few hours changing to pale green, the clubbed hairs about as long as the segments, erect, or nearly so and white. Length, 3.3 mm. (After Edwards.)

Second stage. Head green, the coronal horns tipped with red, the facial papillae white, ocelli black. Body bright green, the papillae whitish, especially noticeable in subdorsal, supralateral and infrastigmatal lines, each bearing a short, stiff, white hair; under surface, legs and prolegs green. Length 6.6 mm. (After Edwards.)

Third stage (78:18). Similar to preceding, but of a light green color, the supralateral and infrastigmatal rows of papillae yellowish, the former extending to the tips of the horns at the two extremities of the body. Length, 11.2 mm. (After Edwards.)

The remaining stages are very similar, with deepening contrasts (78:19).

Last stage (74:16). Head (78:20) yellow green, the extremity of the horns red; papillae arranged in oblique rows, white; ocelli brown, changing to green. Body yellow green, besprinkled with longitudinally arranged whitish papillae with a dark green dorsal band; a yellow supralateral line edged above with dark green; a similar infralateral line; and a narrow, yellow, infrastigmatal stripe; tails tipped with pink; under side, legs and prolegs pale green. Length, 30-35 mm. (After Edwards.)

Chrysalis (83:6). "Delicate green, sometimes blue-green, the ventral side of abdomen lighter or whitish; the top of head-case and edges of wing-cases next dorsum cream color; surface smooth, glossy." Length, 15.25 mm; breadth, 5.6 mm. (Edwards.)

Distribution (18:5). This is a wide spread species, appertaining to the warmer parts of the United States east of the Great Plains, though occasionally taken far north, in Canada and Nova Scotia: its southern limit is the coast of the Gulf of Mexico, where it has been taken in Florida (Chapman, Thaxter), Alabama (Gosse), and Texas (Strecker). It was long ago reported from Georgia by Abbot and from Carolina by Petiver. Westward it extends to Arkansas (Say), Missouri (Edwards), eastern Kansas (Snow), Fort Niobrara, Nebraska (Carpenter), Iowa (Allen, Austin, Parker, Osborn, Putnam), and Wisconsin (Hoy); northward it has been reported in solitary instances at the Lake of the Woods (Dawson), in Ontario (Saunders) Compton (Gosse) and Rouge District, Quebec (D'Urban), and Nova Scotia (Jones). It is also found near Montreal (Caulfield, Pearson) and even at Ottawa (Fletcher); but it is abundant only in the southern states (Gosse). Edwards, however, states that it is "not very common" in West Virginia, and records a case of great abundance in northern Ohio, though Dury calls it "rare" about Cincinnati.

Within the limits of New England it is very rare; it may be found occasionally upon the banks of the southern Connecticut, where Mr. Emery reports that it is "not uncommon" in certain stations about Holyoke and Mount Tom in Massachusetts. Mr. Sprague and I have both taken it in the Notch between Amherst and Holyoke, Messrs. Dimmock and Sprague on Mount Tom, and Mr. Dimmock south of Springfield. The only other

instances of its capture on record are two battered specimens from Jefferson (Scudder) and three or four at Suncook, N. H. (Thaxter); a few at Orono (Fernald), and Bangor, Me. (Braun), and one at Jamaica Plain, Mass. (coll. Bost. Soc. Nat. Hist.).

Haunts. Mr. Allen states that on the western prairies it occurs in deep, damp ravines in woods skirting the rivers; the specimens from Jefferson were taken in a highway through a wood near a small stream of water. Those from the Connecticut Valley in a shady road through a mountain gap or on the mountain sides. It is everywhere rightly regarded as a forest species.

Life history. According to Mr. Emery, the butterflies are to be found about Mount Tom the last of June; good specimens were also taken by him the first week in July and a few specimens may be found there until the end of the first week in August. Gosse reports his single specimen from Compton to have been taken in July, and the two badly broken ones from northern New Hampshire were found late in the same month. The specimens from the Lake of the Woods, were taken between the middle of July and the middle of August; those captured in Iowa by Mr. Allen during July and early August; the Orono specimens in the latter half of July and the Montreal specimens in August. Probably, therefore, the butterfly is single brooded in the north and lays eggs in August. September 3 is the only date of egg-laying known—in northern Ohio, but this must be regarded as exceptionally late. From this and from Mr. Edwards' experiments with rearing those from northern Ohio, it is pretty certain that the winter is passed as a caterpillar in an early stage of life.

Further south there appear to be at least two broods. Mr. Edwards, writing from West Virginia, says "I have taken the butterfly, in different years, as early as 18th May, and through each month to 1st September, and I apprehend there are three annual generations here, the first in May, the second middle of July, the third late in August, as I have taken fresh examples at these times." Dr. Chapman finds specimens in Florida, from the middle of February to the beginning of May; fresh specimens were taken at the end of May and again in the middle of October. He also records one capture in the middle of August, as does Gosse in Alabama. Abbott in Georgia took the insect April 25 and bred it May 20. It would seem probable from these scanty facts that May and August are the culminating times of the southern broods, and that other appearances of fresh material must be due to the lingering of some individuals in their early stages, so common a phenomenon in neighboring satyrids; and it would appear as if the winter might sometimes be passed in chrysalis in the extreme south. Doubtless the account and illustrations of this insect in the forthcoming number of Edwards' sumptuous *Butterflies of North America* will add considerably to our knowledge.

The food of the caterpillar is grass, though Abbott, who bred it, says distinctly that it "feeds on the sugar berry," *Celtis occidentalis*.

Habits, flight, etc. Gosse (Lett. Alab., 122) says of this butterfly:

It is interesting from its social and gamesome habits. A particular individual will frequent the foot of a particular tree for many successive days, contrary to the roaming habits of butterflies in general. Hence he will sally out on any other passing butterfly, either of his own or of another species; and, after performing sundry circumvolutions, retire to his chosen post of observation again. Occasionally I have seen another butterfly of the same species, after having had his amicable tustle, take likewise a stand on a neighboring spot; and after a few minutes' rest, both would simultaneously rush to the conflict, like knights at a tournament, and wheel and roll about in the air as before. Then each would return to his own place with the utmost precision, and presently renew the "passage of arms" with the same result, for very many times in succession.

Its general flight seems to me to be similar to that of *Cercyonis alope*, but less languid, the wings closing back to back with something of a snap.

When resting, hanging to the under surface of an object, the costal edges of the fore wings are at right angles to the surface, slightly in advance of those of the hind wings, and the wings parted at an angle of about 30°, the antennae a little advanced and more widely spread, as far as I recollect the last, some weeks after observation.

Desiderata. This butterfly is so rare in New England, that in order to become properly acquainted with its history and distribution, every specimen taken should be put upon record, its place and time of capture, its sex and condition noted; particular search should be made in the Connecticut Valley, while other places should not be neglected. The somewhat confusing accounts of its times of appearance in the south and its long continued season at the north indicate some peculiarities of larval or pupal life which are unknown, and to which most careful attention should be paid. Does the caterpillar ever feed on *Celtis*? No parasites are known.

LIST OF ILLUSTRATIONS.—*ENODIA PORTLANDIA*.

- | | |
|---------------------------------------|--|
| <i>Egg.</i> | <i>Imago.</i> |
| Pl. 64, fig. 4. Outline of egg. | Pl. 1, fig. 3. Male, both surfaces. |
| <i>Caterpillar.</i> | 33: 3. Male abdominal appendages. |
| Pl. 70, fig. 9. Caterpillar at birth. | 38: 6. Neuration. |
| 74: 16. Full grown caterpillar. | 52: 5. Side view of head and appendages enlarged, with details of the structure of the legs. |
| 78: 17. Head, first stage. | <i>General.</i> |
| 18. Head, third stage. | Pl. 18, fig. 5. Distribution in North America. |
| 19. Head, fourth stage. | |
| 20. Head, fifth stage. | |
| <i>Chrysalis.</i> | |
| Pl. 83, fig. 6. Side view. | |

SATYRODES SCUDDER.

Satyrodes Scudd., Bull. Buff. soc. nat. sc., ii, (Not Argus Scopoli; cf. Proc. Amer. acad. arts sc., x, 118).
242 (1875).

Argus Scudd., Syst. rev. Amer. butt., 6 (1872).

Type.—*Papilio eurydice* Linn.

And butterflies wander
In silence, at leisure,
Like spirits that ponder
Inscrutable things.

WEEKS.—*Vita vitalis*.

Purblind Argus, all eyes and no sight.

SHAKESPEARE.—*Troilus and Cressida*.

Imago (52:1). Head moderately large, pretty uniformly tufted with rather long hairs; front not very full, protuberant, but not greatly, in the middle beneath, narrower than the eyes, a very little higher than broad, the upper posterior edge very slightly convex in the middle, the lower edge a little abrupt, broadly rounded; vertex small, slightly tumid, moderately long, not broad, a minute tubercle in the middle of either side, and a median ridge posteriorly, taking its rise anteriorly from a short transverse carina at the posterior limit of the swollen portion; anterior edge nearly straight, posterior convex; upper border of the eye scarcely angulated opposite the middle of the base of the antennae. Eyes pretty large, not very full, pilose, with short, very delicate, not very frequent hairs. Antennae inserted in the middle or possibly just behind it, in a broad, deep pit, disconnecting the front and vertex, their bases crowded together and separated scarcely any, if at all, from the edge of the flanks; scarcely longer than the abdomen, consisting of thirty-four or thirty-five joints, increasing in size a little and quite gradually on the apical fourth of the antennae, the last two or three joints diminishing again, and terminating in a bluntly rounded point; transversely circular, the club a little depressed and distinctly carinate beneath. Palpi slender, barely twice the length of the eye, compressed, the apical joint about one-third the length of the penultimate; excepting the apical joint, provided beneath with a tuft of pretty long hairs, compacted in a vertical plane.

Prothoracic lobes similar to those of *Enodia*, minute, expanding upward from the base rather rapidly into a somewhat reniform, bulbous mass when viewed from the front, of nearly equal height throughout, the ends well rounded, the exterior extremity tapering slightly, equally long on the summit, half as long as high, and about three times as broad as high. Patagia very slightly convex, the posterior lobe nearly three times as long as broad, tapering rapidly, the extremity produced nearly as far again, as a uniform finger with a bluntly rounded apex.

Fore wings (38:4) but little produced at the apex; costal border regularly but very slightly convex; outer border the same, the upper outer angle being pretty well marked; inner border straight, the lower outer angle scarcely rounded off. Costal nervure as in *Enodia*; first two superior branches of the subcostal nervure arising close to the tip of the cell, the latter scarcely less than half as long as the wing and twice and a half longer than broad; median and submedian nervures not enlarged at the base.

Hind wings with the costal border regularly though not greatly convex; outer border regularly and considerably convex, excepting a slight excision at the lower subcostal interspace; inner border slightly convex, both of the outer angles broadly and equally rounded off. Veinlet closing the cell striking the median nervure a little before its last divarication, and the subcostal at the termination of the short basal curve of its final branch. First median nervure originating a very little further from the base of the wings than the origin of the second subcostal nervure. No androconia.

Fore legs very small, cylindrical, the tibiae one-third the length of the hind tibiae; tarsi scarcely shorter, consisting either of five joints, of which the first is twice as long as the others together, and they diminishing regularly in length, the apical one

bearing at the tip a pair of very minute, short, slightly curving, tapering spines (♀); or, of one joint only, of which the apical fifth is obscurely and partially marked off, and the apical half of the same conical and bearing an exceedingly minute and short apical pin (♂); fore legs wholly unarmed, excepting by the clothing of their long hairs, not profuse, and diverging only a little, more distinct in the male than in the female. Middle tibiae five-sixths the length of the hind tibiae. Tibiae furnished beneath with lateral rows of moderately long and very slender, not very distant spines, the apical ones developing into long and slender spurs, scarcely tapering until near the apex. First joint of the tarsi equalling four-sevenths of the whole member, the second, third and fourth diminishing a little and gradually in length, the fifth equalling the second; the joints supplied beneath with very numerous, pretty long and very slender spines; claws very delicate, strongly compressed and curved, pretty sharply pointed; pulvillus minute, transverse, semicircular; paronychial broad and nearly circular at base, beyond produced to a long, slender, curving, compressed, nearly equal apex.

Male abdominal appendages: upper organ rather slender, the centrum somewhat compressed, laterally triangular, gently arched above, constricted slightly at the extreme base of the hook, which is a little arcuate, with an independent curve at the level of the upper surface of the centrum, a little longer than it, pointed at tip; sides of the centrum furnished at their upper extremity, close upon the base of the hook, with a single, slender, tapering, straight, backward directed appendage. Clasps rather stout, bullate, shorter than the upper organ, about three times as long as broad, the apical half narrowing, the tip rounded, curved inward and armed with a cluster of minute teeth.

Egg. Of a slightly depressed spheroidal shape, broader than high, perfectly flat at base, well-rounded above, the sides inflated with a very regular, full curve, fullest in the middle of the lower two-thirds. Surface apparently smooth, but covered with very delicate small cells, separated by slender, obscure, apparently sunken bands. Micropyle formed of minute, slightly elongate, generally hexagonal cells, their longest diameter pointing toward the centre, increasing a little in size outwardly.

Caterpillar at birth. Head of equal height and breadth, broadest below, the sides scarcely tapering upward in the lower half, and in the middle of each side a large tubercle; summit of each side occupied in front by a very large, rounded, broad, but not greatly elevated, warty tubercle. Surface nearly smooth, minutely rugulose. Body cylindrical; terminal segment tapering considerably on the apical half and considerably excised posteriorly in the middle, leaving a pair of sharply pointed, but very short, backward directed projections. The body is furnished with a number of tubercles bearing peculiar appendages, as follows: a subdorsal row, one to a segment, placed anteriorly; a laterodorsal, one to a segment, placed posteriorly; a laterostigmatal, one to a segment, placed centrally; and an infrastigmatal row, two to a segment, a posterior, higher, and an anterior, lower one, the latter bearing appendages like those of the rest of the body, the former emitting a single tapering hair of the length of the usual appendages; these (86:38) are straight, rather short bristles of uniform size nearly to the tip, where they are delicately clubbed and squarely docked. Legs rather short, thick, the last segment rounded off, scarcely tapering, armed at tip with a rather short and slender, tapering claw, straight, excepting close to the base, where it is bent at right angles. Spiracles circular, pedicelled, the pedicle somewhat constricted just before the extremity.

Mature caterpillar. Head very full, unusually deep, the summit of either half excessively produced upward and, at maturity, a very little forward, into a slender, regularly tapering, straight, conical horn, as long as the head, the outer sides of which are in almost exact continuation of the sides of the head, and are parallel to each other; but in the earlier stages there is a slight broad constriction near the base, and it is only after two moultings that the horns become at all conspicuous; front of the head a little appressed, though curved from above downward, below the base of the horns, particularly in the earlier stages; apart from the horns the head is broader than high, of exactly the breadth of the first thoracic segment, broadest near the ocelli,

tapering regularly upward, the frontal triangle more than half as high again as broad, reaching considerably above the middle of the head, the sides straight. Surface regular, pretty uniformly and profusely punctate with roundish and oval impressions, the slender walls between which are frequently raised into points, each bearing a very short hair, those on the horns directed toward their apex; triangle smooth. Antennae exceedingly small, the first joint much the largest and mammiform, the third slender and no longer than broad, emitting a very long curved hair. Ocelli five in number, four arranged in an open curve, its convexity forward and a very little downward, the upper two in contact, the third at equal distances from the first, fourth and fifth, the latter being behind the third, and with it and the fourth forming an equilateral triangle; the second much larger than the others, followed in size by the first, the others equal. Labrum rather small, about twice as broad as long, its angles rounded, the front slightly excised and angulated. Mandibles rather small and stout, the edge smooth and equal. Maxillary palpi very small, apparently as in *Oeneis*.

Body long and slender, broadest, though but slightly, on the first abdominal segment, tapering slightly behind; nearly cylindrical, but angulated very slightly at the laterodorsal line, having a slight infrastigmatal fold, and the under surface nearly flat; terminal segment with a pair of horns, very similar in form and length to those of the head, but posteriorly extended, their outer surfaces parallel. Each segment divided by five transverse incisions into sections, which are equal on the thoracic, unequal on the abdominal segments, one incision being at the middle, one in advance of it above the spiracles, the others dividing the posterior half into equal portions. Body studded profusely with minute, hemispherical papillae, from each of which arises a very short, stout, equal, round tipped, backward directed hair. Legs very short, slender, conical, each joint with a ring of short tapering hairs; claws very slender and small, straight beyond the base. Prolegs very short and plump, the hooklets of the ventral pairs eleven in number, very slender, a good deal curved, nearly equal, distant, arranged in the half of a longitudinal oval.

Chrysalis. Head and thorax much appressed in front, so as to present a nearly flat surface at an angle of scarcely 70° with the nearly straight ventral surface of the anterior half of the body. Dorsum of thorax rectangular and mesially carinate on the mesonotum, distinctly though slightly falling off posteriorly, the abdomen scarcely rising to an equal height with the mesonotum in its regular arching backward; the whole abdomen conical and vespiform. Ocellar tubercles obscurely trigonal, scarcely advanced, the space between them scarcely emarginate. Viewed dorsally the head is scarcely half as wide as the thorax, which is equal from the basal wing tubercles backward, and slopes regularly but with a slight concavity forward to the anterior extremity. Inner dorsal margin of the wing-case developed into a nearly straight, but curving and prominent carina, which dies out just before the outer margin. Tongue-case barely reaching the wing tips. Cremaster slender, tapering, quadrate, depressed. Spiracles ovate, lenticular, in a slight depression.

This genus, so far as we know, is represented, like *Enodia*, by a single species, which occurs only in the northern parts of the eastern United States and in Canada. It is a butterfly of peculiar appearance from the softness of its coloring and the delicacy of its markings; the wings are rounded and ample, of a pale mouse brown, their outer border marked with one or two delicately pencilled lines, at some distance from which is a series of dark spots, blind above, ocellated beneath, preceded on the fore wings above by some paler clouds and on both wings beneath by several distant, irregular, slender, dark, transverse streaks.

The insect is single brooded, the butterfly flying in midsummer and the larva hibernating; the chrysalis is suspended at pupation. The egg is

subspherical and almost imperceptibly reticulated. The juvenile caterpillar has an equal, well rounded head and the body is provided on each side with four longitudinal rows of tubercles, each bearing a clubbed bristle. The head of the mature larva is crowned by a pair of very long conical horns, and the last segment of the body is furnished with a pair of similar appendages; the body is minutely pilose and pale green, striped longitudinally with narrow, darker bands, which vary in tint and somewhat in position in the different stages. The chrysalis is similar to that of *Neonympha* but has a slenderer abdomen.

EXCURSUS IV.—THE EGGS OF BUTTERFLIES.

I'd be a Butterfly, born in a bower,
Where roses and lilies and violets meet;
Roving forever from flower to flower,
And kissing all buds that are pretty and sweet.
I'd never languish for wealth or for power;
I'd never sigh to see slaves at my feet—
I'd be a Butterfly, born in a bower,
Kissing all buds that are pretty and sweet.

BAYLEY.—*The Butterfly.*

THE eggs of butterflies are no larger than a pin's head, yet when examined under a lens, which is of course required to see the structure of such minute objects, we may look far before discovering anything more graceful in form or delicate in sculpture; indeed, chancing to study some of our forms during a winter spent in Egypt, I was greatly struck by their singular resemblance to the traceried domes of the famous Cairo mosques. They are composed of a thin, elastic, and usually transparent pellicle—so elastic that they will bound like a rubber ball when falling on a hard surface; where not transparent they are made opaque by cross-lines or ribs, by a general reticulation, or in some lower forms (*Pamphilidi*) by a uniform density of the whole integument. They are always circular in cross section and in general are flattened on the surface of rest; by their form they may be divided into four classes: 1, barrel-shaped, 2, spherical, 3, tiarate or turban-shaped, and 4, hemispherical; or, if we consider their surface sculpture, into three groups: *a*, ribbed, *b*, reticulate, and *c*, smooth. These divisions run into each other to a greater or less degree and nearly all possible combinations are found. With rare exceptions nearly allied forms closely resemble each other, and the degree of resemblance is in general an excellent test of affinity. Not only can species and genera be distinguished by oölogical characters, but many of the larger groups, even as far as the broadest natural divisions of butterflies, may not infrequently be defined in terms of the egg, so that it even becomes a valuable aid to classification.

The barrel-shaped form is sometimes very much attenuated at both ends,

so as better to be described as spindle-shaped, and it is nearly always broader at the base than at the summit, so as to merit the term pyramidal, sometimes much broader, as in *Speyeria*. The truncate top is also very frequently rounded and its edge inconspicuous, and it then runs into the spherical or hemispherical class; but the true barrel-shaped group is always higher than broad. The *Nymphalidae* and *Pierinae* almost always belong to this group, and they are always vertically ribbed to some extent, but the ribs always terminate short of the centre of the summit, either gently or abruptly. Sometimes these ribs are coarse and irregular, running in zig-zag lines from base to summit, so that the egg might almost be regarded as coarsely reticulate; in others the ribs are excessively compressed, mere films, placed edgewise to the body of the egg, glistening in the sunshine like dew-drops, and increasing in size to the summit, where they often form a sort of crown; or they may die out on the lower half of the egg, or fade into a weaker reticulation; or, above, may terminate at the edge of a saucer-like depression which forms the cap of the egg; but everywhere, with more or less distinctness, between these buttressing ribs, the surface of the egg is broken into quadrangular cells by delicate cross-ridges, which often increase in stoutness toward the main ribs, and in their turn buttress them.

The spherical forms include particularly the *Papilioninae*, some *Satyrinae* and the *Hesperidi*, unless these last more properly belong to the preceding group. They are usually smooth, but may also be reticulated or, as always in the *Hesperidi*, ribbed.

The tiarate eggs are very beautiful objects, often reminding one of a miniature sea-urchin without spines, and are characteristic of the *Lycaenidae*, though some of them incline toward the hemispherical form, and all, without exception, are reticulate. In these the surface is never ribbed, but generally covered with a heavy net-work of deep pits, whose bounding walls are rather coarse and rough. The eggs of the *Parnassians* resemble them closely.

Finally the hemispherical eggs, generally more than half as high as broad, and with a slight flattened summit, are smooth and comprise only the *Pamphilidi*, if we except the reticulated *Heodes*, which possibly belongs here as much as with the turban-shaped eggs.

As an architectural form, the egg of a butterfly is exquisitely patterned. With all the variation in sculpture and contour, every curve and every detail of chiselling is in subordination to a central feature — all lead up to a distinct culminating area, the micropyle, or little rosette of cells of the most exquisite delicacy, which crowns the summit of the central vertical axis. Often requiring some of the higher powers of the microscope to discern, the cells are arranged in such definite and regular patterns that in looking at them we seem to be peering through the circular rose-window

of a miniature Gothic cathedral. Sometimes, in the tiarate eggs, this rosette is situated at the bottom of a very deep and narrow well, and can with difficulty be seen. Often their patterns would furnish useful hints to the decorator, and especially for all forms of embroidery, as our plates **67-69** will show. The cells which form the interior of the rosette are the points at which microscopic pores lead into the interior of the egg, and through which it is fertilised. With this in view, we can understand why this rosette should form the goal of movement of every part of the structure.

When freshly laid, the eggs are generally of some shade of pale green, though in the Pamphilidi, with their opaque shells, they are nearly chalky white; but during the development of the caterpillar (or of parasites) within, all sorts of colors may be assumed, often of a rich or almost gaudy hue; these colors are sometimes shown on our plates.

The eggs of butterflies are always laid in full view excepting that in a few instances they are partially concealed by being thrust into crevices. Usually hatching in a few days, they are generally laid upon the very leaves the caterpillar will eat or upon the stem close at hand; but when, as in some cases (only known among Lycaenidae), the egg remains all winter, the butterfly selects the stem, and, as an additional protection, chooses a spot next a leaf-bud, or other projection, or tucks the egg in some crevice of the bark. It is even stated by Salesbury, according to Rennie, and repeated by European writers, that the egg of *Aporia crataegi* may last three years and then hatch, but the statement seems to me fairly open to doubt until verified. For ordinarily the eggs of this species are laid in clusters (whether on leaf or twig I find no statement), and give birth *the same year* to caterpillars which winter in small clusters in webs. All butterflies which winter as eggs feed as caterpillars on trees or shrubs, never on herbaceous plants. As a general rule the eggs are laid singly, but in not a few cases, oftenest found in the Nymphalidae and Papilionidae, they are laid in clusters of from two or three to several hundreds. Sometimes these are rude bunches piled loosely or in layers one upon another; sometimes they are laid in more or less regular single or double rows; sometimes in a single column of three, or four, or even as many as ten eggs, one atop another; or they may girdle a twig like a fairy ring.

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 Seudder, S. H. Butterflies, Chap. I, figs. (1881).
 Werneburg, A. Der schmetterling und sein leben. 150-151 (1874).

SATYRODES EURYDICE.—The eyed brown.

[The eyed brown (Gosse); Boisduval's butterfly (Harris); ten-spotted quaker butterfly (Maynard).]

Papilio eurydice Linn.-Johanss., Amoen. acad., vi: 406 (1763).

Argus eurydice Scudd., Syst. rev. Amér. butt., 6 (1872).

Satyrodes eurydice Scudd., Bull. Buff. soc. nat. sc., ii: 243 (1875); Butt., figs. 19, 36, 120 (1881).

Papilio canthus Linn., Syst. nat., 12th ed., ii: 768 (1767).

Argus canthus Scop., Introd. hist. nat., 432 (1777).

Satyrus canthus God., Encycl. méth., ix: 465, 493 (1819); —Boisd.-LeC., Lép. Amér. sept., pl. 60, figs. 1-4 (1833).

Neonympha canthus Westw.-Hewits., Gen. diurn. Lep., ii: 375 (1851); —Morr., Syn. Lep. N. Amer., 74-75 (1862); —Edw., Can. ent., xv: 64-69 (1883); xvii: 112 (1885); —Fern., Butt. Me., 70-72 (1884); —French, Butt. east. U. S., 232-234 (1886); —Mayn., Butt. N. E., 5-6, pl. 1, figs. 6, 6a (1886).

Debis canthus Herr.-Schaeff., Corresp. zool.-min. ver. Regensb., xix: 72 (1865).

Pararge canthus Butl., Catal. Satyr. Brit. mus., 123 (1863).

Euptychia canthus Kirb., Syn. catal. Lep., 55 (1871).

Satyrodes canthus [Smith], Bull. Brookl. ent. soc., vi: 119 (1884).

Satyrus cantheus God., Encycl. méth., ix: 465, 493-494 (1819).

Neonympha cantheus Morr., Catal. Lep. N. Amer., 10 (1860).

Hipparchia transmontana Gosse, Can. nat., 247 (1840).

Hipparchia boisduvalii Harr., Ins. inj. veg., 3d ed., 305-306, fig. 128 (1862).

Pararge boisduvalii Edw., Syn. N. Amer. butt., 26 (1871).

Figured by Glover, Ill. N. A. Lep. pl. 35, fig. 5, ined.

Creature of air and light,
Emblem of that which may not fade or die,
Wilt thou not speed thy flight,
To chase the south-wind through the glowing sky?
HEMANS.—*Butterfly resting on a Skull.*

Imago (1: 10; 11: 5). Head covered with brown and gray-brown hairs, with a few white ones outside of and behind the antennae, the hinder margin of the eyes bordered, broadly in the middle and below, narrowly above, with white scales. Palpi silvery, slightly clouded, white externally excepting on the apical joint; above fringed lightly with pale brownish on the free portion; beneath fringed with dirty white on the first joint, on the second with brownish and blackish fuliginous, pale on the basal half internally, apical joint blackish brown throughout, tipped considerably with white, and with a few white scales beneath. Antennae dull luteous beneath, above blackish, tinged with reddish luteous on the basal joints, interrupted broadly with white at the base of each joint and slightly touched with white on either side; on the club the white becomes rather faint and the black brownish, excepting on the terminal three or four joints, which are wholly luteous; beneath the four or five joints previous to these are infuscated; tongue luteous at base, beyond more and more infuscated.

Thorax covered above with gray-brown hairs, tinged slightly with olivaceous; beneath with very pale brown hairs. Fore legs covered with slightly darker hairs; other femora covered with pearly grey scales, tinged slightly above and more strongly near apex with pale buff; tibiae and tarsi dull buff-brown; spurs dusky, reddish at tip, mostly concealed by pale brown scales; spines dull luteous; claws testaceous, more dusky toward tip; pad blackish.

Wings above soft mouse brown on the basal half of the wing, beyond paler, considerably so in the ♀. *Fore wings* having the darker portion of the wing limited, at least in the upper half, by a bent line which extends in a slightly concave curve from the subcostal nervure, about midway between the last two divarications, to about the middle of the upper median nervule; is then bent inward at about a right angle and

soon dies out; just within this border, and often half way to the apex of the cell, the wing is much darker and often blackish; the extremity of the cell is marked by a slender, blackish streak; the outer two-fifths of the wing is considerably paler, especially in the ♀, becoming often nearly straw colored, especially next the border of the darker portion; toward the outer border it gradually deepens, the margin itself being narrowly edged with blackish brown, and followed at less than half an interspace's distance, by a similar, but broader dark line in a narrow, pale stripe, which borders it equally on either side; the darker portion of the border deepens both in intensity and width at the apex of the wing; and in the lowest subcostal, subcosto-median and two median interspaces, there is a nearly straight row, subparallel to the outer border, of roundish, blackish spots; that in the upper median interspace removed a little inwards; each bordered with a faint, dull yellowish annulus, the lower occasionally with a white central dot; each whole spot scarcely occupying, even in the narrowest interspaces, the entire width between the nervules; excepting the upper one, they are situated midway between the border of the darker base, and the submarginal dark line; fringe uniform pale gray-brown. *Hind wings* brown, with the division between the darker and paler portions of the wing less distinctly marked than in the fore wing; sometimes it is scarcely at all apparent, in others it passes in a nearly regular course from the middle of the costal margin, to the upper branch of the median, as far beyond its base as it is from the first divarication of the median, and then, bent at nearly right angles, crosses the lower interspaces in a series of waves, toward the middle of the outer half of the inner border; the outer margin is marked just as in the fore wing, and there is a submarginal curving row of six nearly equal, roundish or longitudinally subovate spots in the subcostal, subcosto-median, median and submedian interspaces, their outer limits usually about an interspace's distance from the outer border, and each composed of a small, roundish black spot, with a central white dot, and narrowly and equally margined with pale yellowish, this a little more broadly with pale brown, and this again with a similar pale annulus, the last barely crowded between the nervules; the spots in the subcostal interspaces are not infrequently wholly blurred with blackish, effacing the successive annuli, and that in the medio-submedian is usually fainter than the others and often subobsolete; the guttered portion of the inner border is paler than the rest of the wing; fringe as in the fore wings.

Beneath, slaty brown on the basal half, paler beyond, the two tints separated by an irregular, slender, dusky stripe. *Fore wings* having the apex of the cell marked by a slender, brownish fuscous stripe, and the cell crossed in the middle of the outer two-thirds by a similar, gently curving stripe, its convexity outward, beneath striking the origin of the first median nervule, and sometimes faintly continued over the medio-submedian interspace; the similar and equal though irregular stripe, which limits the darker basal tint of the wing, starts from the subcostal nervule at the origin of the penultimate superior nervule, and passes tremulously, but with a direction in general parallel to the stripe at tip of the cell, to the upper median nervule, just above which it generally protrudes slightly outward and here is slightly bent, passing in a slightly irregular course as far as the middle of the lower median interspace, having a general direction at about right angles to the lower median nervule, below which it continues to the submedian nervule in the same general direction, but bent in a broadly zigzag course; outer margin delicately edged with blackish brown, followed by a slender, dusky line at less than half an interspace's distance; between these two, the narrow space is pale, dull, umber yellow, and the submarginal line is bordered narrowly within with pale; midway between this submarginal line and the extra-mesial stripe, at least on the lower half of the wing, is a series of four ocellate spots in the lower subcostal, subcosto-median and median interspaces, generally diminishing regularly in size upwards, each consisting of a roundish black spot, with a white or bluish white central dot and annulated distinctly with pale yellowish, and this again more narrowly and less distinctly with dusky; the four spots are then enclosed in a common, equal, broader, but very faint encirclement of pale, following their curves; the outer half of the wing above the subcostal vein is clouded with fuscous, so as to be nearly or quite as

dark as the basal portions; fringe as above. *Hind wings* with the apex of the cell marked in the subcosto-median interspace by a slender, brownish fuscous stripe; within this is a nearly continuous similar stripe, crossing the costo-subcostal interspace sinuously from without inwards, and striking the subcostal nervure at nearly its own length previous to the first divarication; crossing the cell in a slightly tremulous course from a little without the same point on the subcostal to as far within the first divarication of the median; and continuing in very nearly the same course to the submedian. The extra mesial stripe starts from the costal, midway between its apex and the origin of the inner stripe, and runs subparallel to the latter as far as the middle of the upper subcostal interspace, where it bends outward and as far as the middle of the subcosto-median interspace, is directed subparallel to the outer limits of the cell, often tremulous in its course; it then passes in rather a full curve, crossing the upper median at the base of its straight portion to the middle of the lower median interspace, where it is bent at less than a right angle outwards and crosses in a sharp, high curve, to the middle of the next interspace, where it is again curved strongly outward, terminating at the submedian at more than an interspace's distance from its tip. The outer border is marked as in the fore wings, and there is a submarginal curving row of six pretty large, subequal ocelli, one in each interspace between the costal and submedian nervures; each consists of a moderately large, round, black spot, having a minute, central, white, or generally bluish white, centre, and surrounded by a rather broad annulus of ochrey yellow, which is again narrowly bordered with brownish, and this with a somewhat obscure, pale ring; in the lowest there are two small black spots, each with a white, central dot, enclosed in a common, transversely oval, yellowish field, which is bordered as in the others; in the lower three, the dusky rings scarcely reach the boundaries of the interspaces; in the upper one the yellow annulus reaches them, while in the two between the brownish ring reaches these; the middle four are at a nearly equal distance from the outer border, their outer limits removed by about an interspace's distance; the lower is a little nearer, while the upper is within the middle of the interspace in which it occurs; fringe as in the fore wings.

Abdomen above dark brown, paler at the segment tips; beneath whitish. Appendages of the male (33:2): upper organ with the middle two-thirds of the inferior margin of the hook straight, the tip curved a little downward, and rather finely pointed, the middle as broad as the tip of the clasps; lateral arms very slender, tapering regularly, finely pointed, a little more than half as long as the hook, straight, with the tip slightly curved inward and upward. Clasps as broad as the transverse diameter of the centrum of the upper organ, the lower margin broadly but slightly protuberant below the base of the upper margin, beyond tapering rapidly, but a little irregularly to the tip, toward the apex of which it becomes a little twisted, and terminates in an equal, round-tipped extension, which is about twice as long as broad and less than one-fourth the width of the base of the clasp, bent inward and a little upward, and armed at the tip with a close cluster of very minute prickles.

Measurements in millimetres. Length of tongue 8 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	22.	23.5	25.75	23.	25.25	25.75
antennae.....		9.75			10.25	
hind tibiae and tarsi...	6.25	6.5	7.	6.25	6.5	7.
fore tibiae and tarsi...	1.8	1.8	2.2	2.5	3.	3.

Egg (64:10). Surface smooth to the unaided eye, covered with exceedingly fine granulations in nearly circular cells, which average .03 mm. in diameter, and are separated from each other by paler, smoother, very slightly sunken bands .0028 mm. in width; color very pale green, almost white; height, .97 mm.; greatest diameter, 1.07 mm. Micropyle (67:2) .2 mm. in diameter, the cells varying from .01 mm. to .025 mm. in diameter, bounded by exceedingly delicate raised lines; in the centre of the micropyle there is a circular cell, only .00425 mm. in diameter, from which diverge in stellate form the seven or eight slender rays, less than .01 mm. long, which bound the first circle of cells.

Caterpillar. *First stage* (70:1): Head (78:9) light yellowish brown, the sutures marked with brown and the summit tubercles brownish; there are a few short, curving hairs scattered irregularly, among which may be specified one on the summit of each tubercle and lateral wart, and a very long, tapering one, directed forward, springing from the anterior base of the summit tubercles; ocelli black; mouth parts concolorous with the head, the mandible tips reddish. Body very pale, uniform, greenish yellow, almost white; when it is full grown at this stage, however, it is pale green with the same longitudinal lines as in the next stage; a very faint, pale, stigmatal line, the body below it, and the legs and prolegs paler; first thoracic segment with a transverse row of little papillae of the color of the body, bearing bristles, directed slightly forward; bristles of the body pellucid. Length of body, 3.2 mm.; breadth of body anteriorly, .44 mm.; posteriorly, .36 mm.; of head, .7 mm.; length of the bristles of the first thoracic segment, .12 mm.; of ordinary bristles, .06 mm.; breadth of same, .007 mm.; length of terminal hairs, .24 mm.

Second stage. Head (78:10) pale green, the horns pale yellowish brown at tip and connected with the anterior row of ocelli by a brownish line; posteriorly the horns have a pale streak, and between each streak and the ocelli the cheeks are dotted with white upon the raised points; ocelli blackish in a brown field; mouth parts greenish, the jaws tipped with reddish brown. Body uniform grass green, clothed with very short, delicate pile, and striped with narrow, longitudinal streaks of white, viz.: a subdorsal line, a distinct laterodorsal stripe, connecting the bases of the conical horns at either end of the caterpillar, faint lateral, suprastigmatal and infrastigmatal lines; terminal horns pale green, tinged apically with yellowish brown; spiracles pale, bordered with luteous; legs green, yellowish brown at tip; prolegs green. Length, 9.5 mm.; breadth, 1.25 mm.; length of cephalic horns, .3 mm.; of abdominal pair, .2 mm.

Third stage. Head grass green, the projecting part of the horns pale yellowish brown tipped with black; otherwise as in previous stage. Body as in preceding stage, excepting that the lower longitudinal lines are all distinct, and that between the subdorsal line and laterodorsal stripe, the space is filled on the abdominal segments with a fainter, irregular, white stripe, scarcely separated by a green thread from the bands on either side of it; and by the presence of a similarly faint or even scarcely perceptible dorsal thread; the terminal horns are white. Length, 13 mm. including both pair of horns; breadth, 1.25 mm.; length of cephalic horns, .6 mm.; of terminal horns, .6 mm.

Fourth stage. As in preceding stage, excepting that the projecting parts of the cephalic horns are roseate, as are also the tips of the caudal ones. Length including horns extended, 16 mm.; breadth, 1.4; length of cephalic horns, 1.1 mm.; of caudal, 1.25.

Last stage (74:9). Head (78:11; 86:19) yellow green, the coronal tubercles red, with a brown stripe on either side of the front from near the tip of the tubercle to the ocelli. Body green, striped longitudinally as follows: a dorsal dark green stripe; subdorsal pale green bands, edged outwardly with yellow green; pale green lateral bands through which runs a yellow line; an infrastigmatal yellow stripe. Legs and prolegs pale green. Length, 30 mm. (After Edwards, my own description being lost.)

Chrysalis (83:9). Green, with a dorsal stripe, and on the abdomen a laterodorsal and lateral stripe of buff; the carinate edges of the head case and the alar carinae also buff. Length, 15.5 mm.; breadth, 3 mm. (After Edwards.)

Distribution (18:6). This is a northern butterfly; it has been taken as far south as Long Island (Graef), Staten Island (Davis), and New Jersey (Edwards), and is stated by Kirtland to be excessively abundant in central Ohio and especially in the western prairies, although rare in the northern part of the state, in which last statement Kirkpatrick agrees; westward we have seen it from Michigan (Mus. Mich. Univ.) and central

Iowa (Allen), and it is reported from central Iowa (Osborn), northern Illinois (Worthington, Edwards), Indiana (Edwards) and Wisconsin "not rare" (Hoy). It has been captured at Mingan Island off southern Labrador (Couper), at Quebec (Bowles), Montreal, "abundant" (Caulfield, Lyman) and Ottawa, "abundant" (Billings, Fletcher). It has even been taken at Great Slave Lake, and at Rupert's Fort on the east side of Hudson Bay, but has not been reported from Labrador. To the east it is reported from Colchester Co., Nova Scotia, by Jones.

In New England it is not a very rare insect, especially in the northern and elevated parts. It has been taken to the eastward at Orono (Fernald) and Mt. Desert Island, Me. (Scudder). There is no notice of its capture south of Massachusetts, where it has been taken in Williamstown (Scudder), at various points in the Connecticut Valley (Dimmock, Scudder, Sprague), and by many collectors about Boston where, though not abundant, it is by no means rare; farther north, in the latitude of the White Mountains and as far as Compton, Canada (Gosse), as well as in the Adirondacks of New York (Hill), it will be found extremely abundant by those who look for it in its proper haunts.

Haunts. These are elevated, moist meadows, particularly those lying on hillsides, and it is so restricted to them that one may sometimes find it in a spot but a few acres in extent and search in vain beyond. The only notice of its capture in any other place is of a single specimen by Mr. Allen, from a shady ravine in Iowa. It would probably be found in considerable abundance where it is now considered rare, were it sought for in the proper stations.

Larval habits. The food plants of the caterpillar are the coarser grasses. Mr. Edwards had poor success in raising them on lawn grass; with me they fed on it readily enough. Mr. Fletcher found them feeding by day on *Scirpus eriophorum* and *Carex bromoides*. To escape from the egg, the young larvae bite a channel around the summit, forming a lid about 7 mm. in diameter; but instead of then leaving the egg they frequently eat a second hole on one side and there make their escape; once out, they sometimes devour the whole shell, leaving nothing but the attached base. During their earlier stages, the caterpillars are exceedingly quiet, remaining on a single blade of grass near the tip, from the sides of which they eat long, irregular patches, nearly or quite to the midrib, with very slow movements; they continue thus until several days after their second moult, when they not only begin to eat more rapidly and abundantly, but wander restlessly about from blade to blade; they eat mostly or only by day. When moulting, the horns of the new head are directed forward, lying flat upon the front beneath the old skin. When active, these horns are inclined forward, their hinder edge forming an angle of about 35° with the perpendicular; when at rest, the head is bent beneath the body so that the hinder edge of the horns lies on a line with the dorsal surface of the body;

I have found that the abdominal horns are always held horizontally, whether the caterpillar is at rest or in motion, but Mr. Edwards says that when feeding they are "elevated at about 45° , and separated."

Life history. The insect is single brooded. The imago usually appears about the 7th of July, occasionally as early as the 1st or as late as the 15th, and Morrison records one taken as far north as the White Mountains on June 29; generally it is abundant by the middle of July; toward the end of the month it is much less common, also badly torn and rubbed, but continues until after the middle of August, and Captain Geddes says he has captured it in Canada in September. The female lays her eggs the middle or last of July, and these hatch in from seven to nine days. The first caterpillar which I obtained hatched about the first of August, moulted first on the 14th, again on the 29th and the last time on the 14th of September; after which it remained quiescent four days; others since obtained were hatched between July 27 and August 5, and were very irregular in their growth, backward specimens changing to their third stage September 1, and forward ones to their fourth September 7. Mr. Edwards records similar experience; it is very slow of growth and passes the winter as a larva, nearly or quite full grown.

Habits and flight. The butterflies have a very feeble, delicate flight, dancing lazily hither and thither among the herbage, flying generally but two or three feet above the ground; yet when alarmed their movements are more powerful than one would suppose possible in an insect with wings of so delicate a texture.

Desiderata. Although we know that this insect passes the winter in the caterpillar state, our breeding experiments have not yet been extensive enough or conducted under sufficiently natural conditions to show in just what stages of larval life it does so; nor do we know anything of the places to which it resorts for hibernation. The lethargic action of the caterpillar and the irregularity of growth of different members of the same brood suggest the need of repeated experiments to learn its meaning or to what it leads. The southern and northwestern limits of the range of the butterfly need revision, and no parasites have been discovered attacking it.

LIST OF ILLUSTRATIONS.—*SATYRODES EURYDICE.*

<i>Egg.</i>		<i>Chrysalis.</i>	
Pl. 64, fig. 10.	Outline.	Pl. 83, fig. 9.	Side view.
67:2.	Microscope.		<i>Imago.</i>
<i>Caterpillar.</i>		Pl. 1, fig. 10.	Male, both surfaces.
Pl. 70, fig. 1.	Caterpillar at birth.	11:5.	Both surfaces.
74:9.	Full grown caterpillar.	33:2.	Male abdominal appendages.
78:9.	Head, first stage.	38:4.	Neuration.
10.	Head, second stage.	52:1.	Side view of head and appendages enlarged, with details of the structure of the legs.
11.	Head, fifth stage.		<i>General.</i>
86:19.	Side view, full grown head.	Pl. 18, fig. 6.	Distribution in N. America.
38.	Dermal appendage, first stage.		

NEONYMPHA HÜBNER.

Neonympha Hübn., Verz. bek. schmett. 65 (1816.) Type.—*Oreas fimbriata helicta* Hübn.

Then grand and golden fancies spring
From out my heart on splendid wing,
Like Chrysalis from Life's wintering,—
Burst bright and summeringly, Love!

GERALD MASSEY.—*A Lyric of Love.*

Imago (52:7). Head pretty large, covered above with a thin mass of nearly equal, pretty long, erect hairs. Front a little tumid, a little prominent down the middle, where it barely surpasses the front of the eyes, slightly hollowed above in the middle of either lateral half, a little narrower than the eyes, but somewhat broader than high, squarely terminated above, excepting in the middle, where a slender, narrowing tongue passes between the antennae; the lower edge rounded, a little and broadly thickened in the middle; vertex transverse quadrate, nearly flat, but irregularly so, both in front and behind terminating abruptly by the falling of the edges, both of which are straight; eyes pretty large and full, nearly circular, but slightly higher than broad, slightly truncate behind, scarcely angulated above, naked. Antennae inserted in the middle of a not very broad, pretty deep pit, disconnecting the front and the occiput, scarcely separated by the tongue of the front and touching the sides of the flanks outwardly; a little longer than the abdomen, composed of thirty-five joints, scarcely increasing in size on the middle of the outer half, and so gradually that it is impossible to designate any exact portion as a club, the last joint rounded off apically; the club slightly compressed, beneath slightly and distantly tricarinate. Palpi slender, two and one-half times longer than the eye, strongly compressed, the apical half as long as the middle joint; excepting the apical joint, tufted beneath with very long hairs compressed in a vertical plane.

Prothoracic lobes entirely resembling those of *Cissia*, very minute, appressed, transversely rounded above. Patagia a little and regularly convex, the posterior lobe very broad, nearly twice as long as broad, tapering by the rapid rounding off of the inner edge to a blunt point, the whole faintly falcate.

Fore wings (38:7) as in *Cissia*, but scarcely so rounded on the outer border; hind wings as in the same, but with the outer border considerably more convex, being much more rounded than the fore wings, while in *Cissia* they are similar; the inner border differs also in being less convex near the base, and less excised toward the tip. No androconia.

Fore legs excessively small, the tibiae scarcely more than one-sixth the length of the hind tibiae; tarsi of the same length as the tibiae, in the ♂ composed of two joints, of which the second is minute, and consists only of a conical protuberance a little longer than broad, and not so long as the breadth of the truncate end of the first joint, and both joints unarmed; in the ♀ it is similar, but the first joint is broken into two, the second less than one-half as long as first; wholly unarmed except by long hairs which diverge but little from the leg. Hind tibiae one-eighth longer than the middle tibiae; legs transversely quadrate or subcylindric; tibiae furnished beneath on either side with a lateral row of delicate, rather infrequent, minute spines, the apical ones produced to long and slender spurs; tarsi with the first joint longer than the second, third and fourth together; these diminish slightly in length in the order mentioned, while the fifth is as long as the second; joints covered beneath with many minute spines, the more conspicuous of which are those of the lateral rows, those at the tip of the joints being larger and longer. Claws small and rather delicate, strongly and regularly curved, a little compressed, tapering, pointed; paronychial arising from the heel of the claws, half as long as they, slightly stouter and curving in an opposite direction and not so strongly; pad minute.

Upper organ of male abdominal appendages rather small, the body a little tumid, the hook separated by a rather deep sulcation; hook very much longer than the body, curved considerably downward, shaped much as in *Cissia*; lateral appendages unusually broad on the basal half, beyond tapering to a point. Clasps broad, less than three times as long as broad, tapering apically, but not pointed, the upper edge bearing just before the extremity a large, inward directed, depressed tooth.

Egg. Almost globular, but with somewhat truncate base, the surface uniformly reticulate, with irregular polygonal cells of nearly uniform size, forming shallow lenticular depressions.

Caterpillar at birth. Head large, about twice as large as any body segment, higher than broad, broadest near the base, well rounded except for the presence of large, mammiform or conical bosses, the largest of which are at the summit externally, one on either side directed upward and outward, while a similar smaller one is found in the middle of each cheek; the coronal pair give rise each to two simple, short hairs arising from papillae, the genal to a single hair. Triangle large, much higher than broad, near the base with a transverse row of two pair of minute hair-supporting papillae. Mandibles large, chisel-edged, entire. Body cylindrical, uniform, slightly tapering posteriorly, the terminal segment bluntly furcate. Appendages consisting of slender, delicately clubbed, papillae-supported, moderately short hairs, less than half the length of the segments, excepting on the four last segments where they are sometimes much longer; they are arranged in an anterior subdorsal, a posterior laterodorsal (becoming supralateral on the thoracic segments), an anterior laterostigmal and infra-stigmatal series, the latter double on the abdominal segments.

Mature caterpillar. Head massive, well rounded, deep, narrower than the body, rounded in every direction, broader and deeper below than above, broader than high, higher than deep; the summit produced externally on either side to a conical elevation, studded with conical papillae, which otherwise are rather sparsely distributed over the head, each giving rise to a fine hair shorter than itself. Ocelli five in number, two attinent in front, the lower of them four times as large as any of the others, two others forming a row with the large ocellus, equidistant, and the posterior one at the angle of the right angle, connecting the lowest (just above the antenna) and the lower edge of the large one. Body slender, stoutest in the middle, gently tapering in either direction but especially posteriorly, the final segment terminating in closely approximate, slightly divergent, long and slender, conical, not finely pointed, papillate forks; abdominal segments divided by transverse sulcations, which are fainter below the middle, into six subequal divisions, the anterior the broadest, and the next, on which the spiracles occur, a little larger than the remainder; surface studded rather abundantly and with much uniformity with minute conical papillae, each supporting a not delicate tapering hair of about its own length; spiracles elevated, long-oval, subfusiform. Legs short, stout, conical; claws exceedingly delicate, straight. Prolegs very short and stout, tapering.

Chrysalis. Head and thorax much appressed in front so as to present a nearly flat surface, at an angle of 75° or less with the nearly straight ventral surface of the anterior half of the body. Dorsum of thorax abruptly rounded at almost right angles, distinctly carinate on the mesothorax, scarcely contracted at the metanotum, but the abdomen enlarging slightly on the first three segments and then diminishing with some rapidity and regularity, the movable joints having a conical form. Ocellar tubercles trigonal, more or less prominent, the head about half the width of the thorax, which rapidly narrows toward it. Inner dorsal margin of the wings developed into a strong carina which dies out just before the outer margin. Tongue case terminating some distance short of the wings. Cremaster considerably extended, tapering, depressed. Spiracles ovate, slightly embossed.

This genus is nearly allied to *Cissia*; like it, it is peculiarly American and probably occupies a very similar extent of territory, although seldom

found north of the southern United States, where it has two representatives; one of these has been known to occur in close proximity to New England.

The butterflies are of a nearly uniform dark brown, the upper surface immaculate, excepting sometimes a submarginal row of dark spots on the middle of the hind wings; the under surface is traversed by a pair of distant, darker or lighter, slender stripes across the middle, and, in addition, in the middle of the outer half of the hind wing, a series of longitudinally fusiform, ocellate spots or a very large brightly colored spot, apparently formed by a blending or suffusion of these.

Little has been published concerning the seasons of these butterflies. There are probably at least two annual broods, and the winter is passed in the larval state. The eggs are nearly globular and reticulate. The caterpillars are much like those of *Cissia* in shape, but are slenderer, taper more toward the head, are longitudinally striped with shades of green, and have a more distinct coronal tubercle, sometimes one as long as in *Satyrodes*, which it then strongly resembles. The chrysalis also closely resembles that of *Cissia* in shape, but is slenderer, the head is more produced, the ocellar tubercles project beyond the front of the head, while the abdominal segments taper so as to be almost conical, and have no longitudinal carinae.

EXCURSUS V.—THE MODES OF SUSPENSION OF CHRYSALIDS.

Brown shell first for the butterfly
And a bright wing by and by.

Butterfly, good-by to your shell,
And, bright wings, speed you well.

ROSSETTI.—*Chimes*.

WITH few exceptions, the caterpillars of butterflies do not and those of moths do make cocoons or construct cells in which to change to chrysalids, and the transformations of the former are, also with rare exceptions, carried out in the open air, albeit often in concealment. Yet the silken shrouds made (with but two or three known exceptions) by all the caterpillars of butterflies, when about to assume the chrysalis stage, must certainly be looked upon as remnants or reminiscences of cocoons which become less and less marked as we recede in structure from the moths.

Thus the cocoon of the moth is usually a more or less dense structure, in which the pupa lies loosely in a horizontal position; or it is made partly of foreign substances connected by a close tissue of silk, answering the same end; or it may be a compact oval cell in the ground, sometimes lined with silk. The lowest family of butterflies, the skippers, also under-

go their transformations in a cocoon, generally made in large part of dried leaves and other foreign matters, a light, fragile affair it is true, but still unquestionably a cocoon. One or two other butterflies also make a slight cocoon wherein to change to chrysalis, and these few instances, such as *Parnassius* and *Zegris*, are found only in the family *Papilionidae* which follows directly after the skippers. A single instance, however, has recently been brought to light by Mr. W. H. Edwards in which an *Erebia*, a species of *Satyrinae*, makes what may possibly be called by courtesy a slight cocoon, by weaving a few grass blades together.

The skippers, however, do not lie loosely in their cocoon as do the pupae of moths, but spin at either end a Y-shaped shroud, into the centre of one of which they plunge their hooked tail, while in the upper loop of the other, they rest their body, changing the form of the upper arms of the Y from a V to a U. It is, however, often difficult to distinguish the form of the Y in the shroud into which the tail is plunged, as it is much smaller than the other, and often more or less mixed with the threads which form the end of the cocoon proper. Now when we reach the next family, the typical butterflies (*Papilionidae*), the cocoon, save in the exceptional instances mentioned, is lost; while the silken attachments of the chrysalis still remain, modified to suit the circumstances. Instead of the Y-shaped band, wherein to plunge the tail, a carpet of silk is woven upon some branch, into the midst of which the hooks are thrust, while the omission of the stem of the other Y leaves a U-shaped loop or girt about the middle. Sometimes at least, among the few instances in which a cocoon itself is spun, the chrysalis within is still attached to the objects about it, in the same way as is normal to the other members of the family. But in other instances the published notices concerning this point are too vague to allow definite statement. To accommodate the chrysalis thus hung next a solid substance, instead of in the middle of an oval cell, the segments of the abdomen must curve upward toward the ventral line (for the chrysalis lies back downward), and thus the ventral line becomes straight, while the dorsal is strongly arched. This condition of things is perpetuated and often intensified in the next higher family, the gossamer-winged butterflies (*Lycaenidae*), which differ in this respect from the typical butterflies only in the closer binding of the girt around the middle. In the highest family, the brush-footed butterflies (*Nymphalidae*), the girt around the middle is lost and the chrysalis hangs suspended by the tail alone. The chrysalis in this instance usually hangs perpendicular or nearly so, but in a few instances the cremaster, or special development of the last ventral segment for the attachment of the anchor-like hooks, is elongated, and has hooks attached not only at the tip but down the sides, thus enabling the chrysalis to remain rigidly horizontal or almost horizontal, although attached only by the hooks at the tip of the abdomen.

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We see, therefore, a regular progression from the lower to the higher butterflies, in the loss, first, of the cocoon, next, of the girt; and, as if this were not enough, some of the highest butterflies (among the Satyridae) have even lost the last remnant of silk and fallen to the ground, where, amid stubble or in crevices in the ground, they undergo their transformations without more ado. In one instance, as we have seen, the stubble about them is caught together to form a semblance of a cocoon, in which, however, the chrysalis is found wholly unattached, with its anterior end uppermost, a directly opposite position to that in which the Nymphalidae generally are found. Now, as if to show that this suspension of the chrysalis by the tail alone is a stage beyond that of hanging by the tail and girth, we have a clear proof that all these Suspensi (Nymphalidae), as Boisduval happily calls them, have passed through the stage of the Succincti (Lycaenidae, Papilionidae), in the fact that the straight ventral surface of the abdomen, assumed perforce by the Succincti, when they left the cocoon stage and became attached to hard surfaces, still remains in the chrysalis of most brush-footed butterflies, where it no longer serves any purpose; as clear and striking an indication that the Suspensi outrank the Succincti, as that the pupa is higher than the larva.

What sort of arguments were formerly used by a certain class of speculative philosophers may be judged from the following passage published fifty odd years ago, in which the author maintains an opposite thesis:

"The chrysalis of the [typical] butterfly, the pre-eminent type of annulose animals, is fixed with its head upward, as if it looked to the pure regions of heaven for the enjoyment it is to receive in its last and final state of perfection; but the chrysalis of the brush-footed butterflies, whose caterpillars are stinging, is suspended with the head downward to the earth, thus pointing to the world, as the only habitation where its innumerable types of evil are permitted to reside; or to that dark and bottomless region, where punishment awaits the wicked at their last great change." (Swainson, Geogr. and class. anim., p. 248. London, 1835.)

NEONYMPHA PHOCION.—The Georgian satyr.

Papilio phocion Fabr., Entom. syst., iii: 218-219 (1793).

Neonympha phocion Westw.-Hew., Gen. diurn. Lep., ii: 375 (1851).

Euptychia phocion Butl., Catal. Satyr. Brit. mus., 37 (1865).

Megisto phocion Scudd., Syst. rev. Amer. butt., 7 (1872).

Papilio areolatus Smith-Abb., Lep. ins. Ga., i: 25-26, pl. 13 (1797).

Satyrus areolatus Bois.-LeC., Lép. Amér. sept., pl. 63, figs. 5-8 (1833).

Neonympha areolatus Westw.-Hew., Gen. diurn. Lep., ii: 375 (1851);—Morr., Syn. Lep.

N. A., 74 (1862);—Edw., Can. ent., xiv: 163-166 (1882);—French. Butt. east. U. S., 237-238 (1885).

Euptychia areolata Butl., Proc. Zool. soc. Lond., 1866, 498-499 (1866).

Oreas fimbriata helicta Hüb., Samml. exot. schmett., Lep. i, Pap. i, Nymph. viii, Oreades F., fimbriata c (1806-19).

Neonympha helicta Hüb., Verz. schmett., 65 (1816).

Papilio ——— Abb., Draw. ins. Ga. Brit. mus., vi: 27, figs. 54-55.

Figured by Glover, Ill. N. A. Lep., Pl. A, fig. 24; pl. E. fig. 1; pl. F. fig. 12, ined.

Love him, or leave him alone.

WORDSWORTH.—*Redbreast and Butterfly.*

Iéu, bello roso vierginello,
M'espandirai dins l'espinas!

—O Magali, se tu te fas
La roso bello
Lou parpaïoun iéu me farai,
Te beisarai.

MIREIO.—*Mistral.*

Imago (14: 7). Head covered with long pale brown hairs, often with an olivaceous tinge, mingled, especially behind, with some dusky hairs. Palpi at base sordid white, beyond, on the sides and above, pale cinereous tinged slightly with buff; fringed beneath with a long compressed mass of blackish brown bristles, flanked on the inner side with a thin fringe of whitish bristles fully as long as they, and on the outer side by a thinner, shorter and unequal fringe of similar bristly scales. Antennae luteous and in large part naked, the upper surface covered with dark brown scales, more broadly at the apex than at the base of the joints, becoming less and less abundant beyond the middle, disappearing entirely in the middle of the apical half, and edged both interiorly and exteriorly with whitish scales which nearly meet upon the under surface, especially toward the base of the antennae. Tongue luteous throughout.

Thorax covered above with hairs of the color of those on the head, those on the patagia most distinctly tinted with olivaceous, beneath a little paler. Legs rather dark and uniform brown, pretty heavily and uniformly flecked with pale cinereous scales, sometimes almost to the exclusion of the brown ones. Spurs reddish luteous, deepening toward tip, where it is blackish, but excepting there covered with cinereous scales; spines pale; claws reddish luteous, dusky at tip; paronychiae luteous.

Wings above uniform soft dark, or mouse, brown, the fringe of the same color, but with a very inconspicuous, very slender, darker line in the middle of the basal two-thirds, beyond which the fringe is thinner.

Beneath slightly paler, with a faint grayish tint, becoming olivaceous in the basal half of the wing, caused by a slight powdering of scales and short hairs of these colors. *Fore wings* with four faint, transverse, narrow, ochreous stripes; two in the middle and two next the margin; the first traverses the cell in a nearly straight line from the base of the first superior subcostal nervule to midway between the bases of the first and second median nervules, turns inwards if it passes this point and stops at the lowest median nervule, close to its base; or crosses a portion of the interspace below, opposite the extreme base of the same nervule; the second is a little sinuous and irregular in direction, passing from the subcostal nervule, just beyond the origin of the fourth superior nervule, toward the middle of the cell, but bent in the middle of the basal two-fifths of the lowest subcostal interspace, and passing in a slight curve, opening outward, to a little beyond the middle of the submedian nervule, crosses the upper median nervule just beyond the extremity of the cell; the third runs parallel to the outer margin, and is distant from it by the width of half an interspace; the fourth is separated from the margin by only its own width; the two median stripes are of about the width of the basal expansion of the median nervule and the outer ones a little narrower; the middle half of the space between the outer ones is flecked with gray, which is more conspicuous, by contrast, than the almost equally abundant powdering of the wing for some distance within the third stripe; just beyond the middle of the upper median and subcosto-median interspaces, these gray scales form a delicate, very inconspicuous, minute ring of the diameter of the larger stripes only, enclosing a fuliginous dot free of such scales, which is almost imperceptible when the annulus is absent; outer margin edged very narrowly with a black line; fringe as above. *Hind wings* also with four transverse, narrow, ochreous stripes, but a little more distinct and slightly broader than those of the fore wings and equal in breadth; the first one crosses the wing in an irregular slightly sinuous course; starting from the tip of the costal nervule, it passes in a curve opening outward to the first divarication of the subcostal nervule, crosses the cell in a nearly straight but gently sinuous course to the first

divarication of the median nervure, continues in the same direction to the submedian, and then, attenuating, passes toward the middle of the extremity of the interspace, which it does not quite attain; the second median stripe passes from a little beyond the middle of the upper subcostal nervule in a straight line to the extreme base of the straight portion of the lowest subcostal nervule, creeps, attenuated, around the outer edge of the cell, and starting again from the extreme base of the middle median nervule passes, in a scarcely curved line opening outward, toward the middle of the extremity of the medio-submedian interspace, which it fails of reaching, but close to which it joins the third stripe, which is submarginal and, starting from this point, passes parallel to the outer margin, with its interior border at nearly or quite the width of an interspace from it, until it attains the other extremity of the second stripe; the fourth stripe extends from the upper subcostal nervule to the middle of the submedio-internal interspace, separated from the outer border by only one-half its own width; the space between the two outer stripes, excepting next the stripes themselves, is abundantly flecked with pale gray; the space between the two middle ones similarly, but less abundantly flecked, with the exception of four to six, usually five spots, one in each of the interspaces between the middle subcostal nervule and the submedian nervure; these spots are longitudinally obovate, but variable both in form and length, black, flecked lightly with irregular minute clusters of brilliantly metallic steel-colored scales, and occasionally with a little patch of pale yellow scales; the whole spot is also distinctly and equally bordered with pale yellow, and the upper and lower spots are sometimes so small that nothing but the border and a few metallic scales remain; these spots are situated in the middle of the interspaces, one-third to one-half of whose width they occupy, with their exterior edges removed from the interior edges of the third transverse stripe by half the width of the latter; the three middle spots are from two and a half to three times as long as broad, and show a tendency to greater width toward their base than toward their apex; the upper spot is always the smallest and occasionally almost obsolete. The outer edge of the wing and the fringe are as in the fore wing.

Abdomen above blackish brown, beneath the same, very heavily flecked with gray or tinged with yellow like the hairs at the extremity. Male appendages (33:8): upper organ a little arched both longitudinally and transversely; hook nearly straight, but bent downwards, compressed above, expanded and depressed below, forming a regular, slender, lanceolate plate, extending its whole length; viewed laterally, the hook tapers regularly to the slightly downward pointed tip, and is more than four times as long as high and about six times as long as broad; each side of the centrum furnished at the posterior edge with a pretty large and stout, backward directed, compressed lateral arm, nearly straight on the basal half, beyond tapering to a fine point and bent slightly downward, next the tip curved a little inward, the whole as long as the hook. Clasps rather broad at the base, between three and four times as long as broad, scarcely narrowing before the apical third, the whole slightly arched, the apex tapering regularly to a point, the upper edge bearing, just before the middle of the apical third, a triangular, nearly horizontal, depressed, slightly falcate, forward curved, finely pointed tooth, twice as long as broad, besides which, the upper edge is bent over slightly and broadly in the same sense at the middle of the clasp.

Measurements in millimetres. Length of tongue, 3.75	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	16.5	16.75	19.			
antennae.....	7.	7.	7.9			
hind tibiae and tarsi..	4.	4.				
fore tibiae and tarsi..	.75	.75				

Egg (64:9). Globular except for the truncate base which takes off less than one-tenth the height; cells not varying much in size, their average diameter being about .03 mm., but considerably in form, some being of nearly equal diameter in every

direction, while the larger diameter of others, rarely exceeding one and a half times the shorter, may lie in any direction; all are more or less angular, but all the angles are more or less rounded; the depressions are shallow and wholly smooth, the cell walls low and rounded. The diameter of the egg is about a millimetre and its color pale green.

Caterpillar. *First stage* (70:11). Head (78:15) luteo-testaceous, the surface broadly reticulate with faint lines but otherwise smooth. Body delicate green, afterwards changing to decided green, with longitudinal whitish stripes on either side of the dorsal line and along the lateral and stigmatal lines; legs and prolegs green; scattered hairs white; ranged clubbed hairs black, not a third as long as the tapering hairs of the head, except on the last segments where they are half as long again as the head hairs. Length, 3 mm.; breadth of head, .7 mm. (Principally after Edwards.)

Second stage. Head red-brown, with two green patches on either side the suture in front; frontal triangle and back of head deep green, the ocelli emerald green; sometimes the head is wholly green and the coronal tubercles reddish; or a horizontal brown band may traverse the front. Body green, the caudal fork faintly red; the numerous, fine, bristle-bearing papillae of the same color, excepting in yellowish, longitudinal stripes as at the preceding stage; under surface, legs and prolegs green. Length, 6 mm. The following stages are very similar. (After Edwards.)

Last stage (74:8,12). Head (78:16) pea-green, the coronal projections, except their base, testaceous, the mouth parts and lower edge of triangle pale testaceous; papillae pale green with pale or black fine hairs, interspersed sparsely but uniformly with similar white papillae; ocelli emerald green in brown rings. Body yellow green, the numerous papillae of the body color except in the longitudinal stripes, where they have a more distinct serial arrangement, and are yellow, forming slender, yellowish, longitudinal stripes, viz., a subdorsal stripe adjoining a dorsal stripe of a deeper green than usual; a lateral extending to the tips of the caudal fork, a ventrostigmatal, and between the last two a pair of less distinct or more diffused stripes; caudal fork reddish; under surface with legs and prolegs green; spiracles buff. Length, 30 mm. (From blown specimens and Edwards' description.)

Chrysalis (83:10,11). Green, all the carinate portions cream color, the wing cases closely irrorate with the same. Surface of body, excepting the head, with delicate, irregularly longitudinal, transversely and very finely striate, embossed vermiculations paler than the ground. Length, 12 mm.; breadth of head, 2.5 mm.; of thorax and abdomen, at most, 5 mm. (From dried specimens and Edwards' description.)

Distribution (18:7). This butterfly is strictly a southern species, and would not be introduced in this part of this work, had not Mr. Edwards received specimens taken at Morristown, N. J., rendering it not altogether unlikely that it may yet occasionally be found on Long Island. The only other localities from which it is recorded are Atlantic City, N. J., where it was sufficiently common not to be an accidental visitor (Aaron), along the creeks in the mountain valleys by the boundary of North Carolina and Tennessee "common" (Aaron), Alabama (Gosse), Georgia (Abbot), Appalachicola (Chapman) and Indian River, Fla. (Wittfeld), and Texas (Strecker).

Food plant. Dr. Chapman has reared the caterpillar in Florida on *Panicum sanguinale* Linn. Mr. Edwards had difficulty in raising it on our ordinary grasses and found that by selecting one of the coarser species, *Dactyloctenium aegyptiacum*, the caterpillars fed more readily, and were healthier.

Life-history and habits. Very little is known of the seasons of this insect, but there seems to be more than one brood a year, eggs being laid in southern Florida, according to Edwards from Wittfeld's observations, early in May and in July; these were carried to imago (in the north) early in August and at the end of August respectively. Abbot took the butterfly in Georgia on June 5, Gosse in Alabama on June 12, while according to Edwards' observations, the egg state lasts about six days, the caterpillars require in the north from one to two months to feed up, and the chrysalis hangs about ten days. It would seem probable that the winter period is passed by the nearly mature caterpillar.

According to Mr. Edwards, caterpillars reared by him in West Virginia had only four stages (moulting but three times), while those reared for him by Mrs. Peart in Pennsylvania passed four moults, and he compares the diameters of the cast heads of the two sets; but his figures seem to make it probable that he overlooked one moulting in his own observations, it being highly improbable that in one moult the head should have enlarged its diameter two and a half times, as his figures indicate; while the difference between the size of the heads in the last moulting before pupation, would, if this error had been committed, be less than twelve per cent, which the unquestionable difference of twenty per cent at pupation would make entirely probable.

Abbot says that he found the butterfly common in Georgia "in oak and pine woods, on the sides of the branches of trees."

Desiderata. Though the early stages of this butterfly are now described, its life history and seasons are almost wholly unknown and must be elucidated by southern observers. Nothing is published of the habits or haunts of the insect in any part of its life beyond the meagre fragments above; even its distribution is very imperfectly determined, so that were we not acquainted with the early stages, we should have to consider this one of our least known butterflies.

LIST OF ILLUSTRATIONS.—NEONYMPHA PHOCION.

<i>General.</i>		<i>Chrysalis.</i>	
Pl. 18, fig. 7.	Distribution in North America.	Pl. 83, figs. 10, 11.	Side view.
<i>Egg.</i>		<i>Imago.</i>	
Pl. 64, fig. 9.	Outline.	Pl. 14, fig. 7.	Male, both surfaces.
<i>Caterpillar.</i>		33: 8.	Male abdominal appendages.
Pl. 70, fig. 11.	Caterpillar at birth.	38: 7.	Neuration.
74: 8, 12.	Full grown caterpillar.	52: 7.	Side view of head and appendages enlarged, with details of the structure of the legs.
78: 15.	Head, first stage.		
16.	Head, final stage.		

CISSIA DOUBLEDAY.

Cissia Doubl., List. Brit. mus. App., 33 (1848). Syst. rev. Am. Butt., 6 (1872). (Not Megisto Megisto Butl., Cat. Sat., 14 (1868); Scudd., Hübner).

Type.—*Pap. clarissa* Cram.

Yet now,
Now, as I stood letting morn bathe me bright,
Choosing which butterfly should bear my news,—
The white, the brown one, or that tinier blue,—
The Margherita, I detested so,
In she came—"The fine day, the good Spring time!"
BROWNING.—*The Ring and the Book*.

Imago. (52:3). Head (61:11) pretty large, thinly tufted above with a loose mass of hairs; front moderately full, rather broadly depressed and slightly hollowed above, protuberant but not prominently so in the middle beneath, a little narrower than the eyes, about as high as broad, terminating squarely above at the base of the antennae; lower edge terminating a very little abruptly, somewhat rounded. Vertex scarcely tumid, moderately long, a slight tubercle in the middle of either side, the posterior edge sharply, the anterior scarcely, convex; upper border of the eye with a strong, rounded angulation opposite the posterior base of the antennae; eyes pretty large, moderately full, naked. Antennae inserted at the middle, in a broad, pretty deep pit, disconnecting the front and the vertex, their bases touching each other on one side and the sides of the flanks on the other; a very little longer than the abdomen, composed of forty-two or forty-three joints, increasing a very little and very gradually in size on the apical half, rendering it difficult to mark out any definite portion as a club, the last two or three joints diminishing again and terminating in a very abrupt cone; transversely circular, the club scarcely depressed, but slightly flattened beneath and also minutely carinate. Palpi slender, rather more than twice the length of the eye, compressed, the apical nearly two-fifths the length of the middle joint; excepting the apical joint, tufted beneath with very long hairs, compacted in a vertical plane.

Prothoracic lobes somewhat similar to those of *Cercyonis*, very minute, the upper portion forming an inflated mass, exteriorly curving downward to a considerable degree, and tapering to a dull point, scarcely more than twice as broad as high, and but little higher than long. Patagia scarcely convex, the posterior lobe very broad and short, somewhat pyriform, the tip scarcely falcate, less than twice as long as broad, rapidly and pretty regularly tapering, the extreme tip blunt.

Fore wings (38:3; 61:3, 4) scarcely produced at the apex, the costal and inner margins being of nearly equal length; costal margin pretty strongly arched at the base, beyond regularly but very slightly convex; outer border regularly though but little convex; inner border straight, almost concave, the two outer angles about equally, and but slightly rounded off. Costal nervure extraordinarily swollen at the base, for a distance equal to more than twice the width of the cell; first superior subcostal nervule arising either a little before (♂) or a little beyond (♀) the origin of the first inferior nervule; second superior nervule arising beyond the tip of the cell; the latter half as long (♀) or a little more than half as long (♂) as the wing, and twice (♀) or two and a half times (♂) as long as broad; median nervure slightly swollen for a very short distance at the base; submedian nervure not swollen.

Hind wings subtriangular; costal border a little arched just beyond the base, afterwards very slightly convex; outer border regularly, though but little convex; inner border considerably convex near the base, beyond slightly so, and beyond the abdomen slightly and roundly excised, the outer lower angle scarcely rounded off, the upper outer angle a little more rounded. Veinlet closing the cell striking the median beyond its last divarication, and the subcostal at the termination of the short, basal

curve of its last branch; first median nervule originating somewhat further from the base of the wing than the base of the second subcostal nervule.

Androconia (46:4) exceedingly slender, twenty times as long as broad, tapering from the rounded base with great regularity over the basal third, and then continuing as a slender uniform thread to the tip, which is delicately feathered for a distance equal to the basal width of the scale.

Fore legs exceedingly small, cylindrical, the tibiae more than one-third the length of the hind tibiae; fore tarsi one-quarter the length of the tibiae, either apparently consisting of a single joint, the apical two-fifths of which tapers considerably and is wholly unarmed but for a minute apical peg (♂); or composed of five joints, of which the first is from two to three times longer than the rest together, they decreasing in size regularly, and all but the last furnished at the tip, beneath, with comparatively large, long and slender, tapering spines (♀); leg otherwise wholly unarmed excepting by long hairs, which scarcely diverge from the leg; other legs compressed; middle tibiae five-sixths the length of the hind tibiae, both furnished with a lateral row of short, slender, not very frequent spines upon the under surface, the apical ones produced to long and slender spurs. First joint of tarsi as long as the rest together, these subequal; joints covered profusely beneath with small, slender spines, the apical ones of the lateral row a very little stouter than the others; claws slender, strongly and regularly curved, a little compressed, delicately pointed; pulvillus minute, transversely oval; paronychial consisting of two fringed members, the upper slender, as long as the claw, straight, tapering in its apical half to a point, the lower broad at base, subtriangular, incurved, the tip produced and pointed.

Male abdominal appendages: upper organ rather small, with the sides of the centrum straight but scarcely compressed, separated from the hook by a rather deep sulcation; hook considerably longer than the centrum, bent downward a little, nearly straight, strongly compressed above, below expanding into an oval appressed leaf, the tip pointed; sides of the centrum furnished near the middle of their posterior edge with a single, long and very slender, sinuate, backward directed appendage. Clasps stout and bullate, about three times as long as broad, the basal two-thirds broad, but tapering apically, the apical third slender, equal and hooked at the tip.

Egg. Nearly spheroidal, the height and width about equal, the top very slightly depressed, and the lower portions of the sides a little inflated. Surface covered with reticulations, forming small, irregular, hexagonal cells, largest on the upper half, and reduced in the micropyle to a delicate, raised tracery of lines forming similar but much smaller cells.

Caterpillar at birth. Head subrotund, twice as broad as the middle of the body, broadest below, each hemisphere surmounted by a globular tubercle, and midway between it and the ocellar field a smaller pyramidal tubercle; each of these and a few still smaller papillae support a simple hair half as long as the width of the head, the coronal tubercles with two; triangle large and high. Body cylindrical, slightly largest in the middle, the last segment slightly forked; papillae pyramidal, arranged on the abdominal segments in laterodorsal anterior, supralateral posterior, stigmatal anterior, and ventrostigmatal anterior series, one to a segment in each row; on the thoracic segments these series are shifted to a laterodorsal anterior, infralateral anterior, suprastigmatal central, and infrastigmatal series, one to a segment in each, excepting the infralateral where there are two close together, the hairs in this case diverging and one longer than the other. All the papillae, including those of the first thoracic segment, support almost perfectly straight, but slightly curved, club-tipped hairs (86:40), nearly as long as the height of the body; spiracles lenticular.

Mature caterpillar. Head rather small, full, deepest in middle and two-thirds as deep as high, well rounded in every direction except that it is angulate above laterally, the angles slightly produced, almost forming a tubercle; face broadest just below the middle, and narrowing more above than below, the cheeks very full; studded everywhere with crowded papillae, which are larger and more prominent on the upper than the lower half. Triangle reaching nearly the middle of the upper half of the head,

very narrow with slightly convex sides, nearly smooth on its lower half. First joint of antennae depressed, mammiform; second very small, cylindrical, about four times as long as broad, and scarcely a fourth the diameter of the first; third minute, as long as broad, and emitting a long and delicate hair. Ocelli as in *Satyrodes*. Labrum small, excessively thin, about twice as broad as long, the front roundly and considerable emarginate. Mandibles very broad, short and stout, though not very large, the edge straight and chiselled.

Body moderately long, gently fusiform, largest rather behind the middle, and tapering more anteriorly than posteriorly, nowhere longitudinally angulate or carinate, the terminal segment moderately furcate. Each segment divided by incisions into six subequal, transverse belts, each carrying a crowded series of minute, excessively high, conical papillae, each supporting a conical pointed thorn shorter than itself; the belt in advance of the one carrying the spiracle is much more fully crowded and broader than the others. Spiracles exceedingly minute, short, oval. Legs very short, conical, rapidly tapering; claws minute, arcuate. Prolegs very short, plump, and rounded, armed at tip with a crowded series of hooklets.

Chrysalis. Head and thorax much appressed in front so as to present a nearly flat surface at right angles to the ventral surface of the appendages. Dorsum of thorax roundly but, excepting for the rapid frontal descent, not strongly arched, tectiform and carinate. Laterally the head is squarely angulate, parallel to the also parallel inner (dorsal) margins of the wing cases, and between the two the thorax rapidly widens. Abdomen large, full, very strongly arched, superiorly depressed between a pair of supralateral carinae, which grow in elevation posteriorly. The inner (dorsal) margins of the wings developed into strong carinae, which follow but not so prominently the outer margin of the front wings. Tongue case exposed throughout its length. Cremaster large, greatly extended, depressed, quadrate. Spiracles rather protuberant.

It is uncertain over how wide a region this genus of small satyrids spreads, but it is peculiar to America and probably extends into the southern continent where nearly allied genera are numerous. Exclusive of the West Indian Archipelago, it is found over the whole of North America east of the Rocky Mountains, as far as southern Canada; within the United States it is represented by two or three species, but only one occurs within New England, where it is confined to the southern and central portions.

The butterflies are of a nearly uniform dark brown, the outer margin of the wings delicately pencilled with darker lines, the upper surface, unless uniform, furnished with rather large, dark ocellated spots in the lower subcostal and lower median interspaces; these are repeated beneath and their number increased by other spots, usually smaller, forming a regular series equidistant from the outer margin; the middle of the under surface is crossed by a pair of distant, dark, nearly straight and parallel lines; the antennae increase so gradually in thickness that it is difficult to state the line of demarcation of the club and the fore legs are more excessively minute than those of any other New England butterfly excepting one.

The species are single brooded and appear very early in summer, the caterpillars hibernating when more than half grown.

The eggs are nearly spherical and covered with minute reticulations. The caterpillars taper toward either extremity; the head is rounded and the last segment of the body furnished with not very long but sharply

conical horns and the whole body striped with pale and darker green. The chrysalids, which hang by their hinder extremity, have a well rounded form, though slightly constricted in the middle, and a pair of well marked, though not prominent, longitudinal carinae on the abdominal segments, by which it is at once distinguished from all our other satyrids; the anterior extremity is abrupt, the head produced a little, the hinder extremity rather rapidly rounded off and the cremaster long and slender.

EXCURSUS VI.—THE GEOGRAPHICAL DISTRIBUTION OF BUTTERFLIES.

The fresh young Flie, . . .
 . . . joy'd to range abroad in fresh attire,
 Through the wide compas of the ayrie coast;
 And, with unwearied wings, each part t'inquire
 Of the wide rule of his renowned sire.
 SPENSER.—*Muiopotmos*.

THE four great families of butterflies are found in every quarter of the globe. All are represented on the inhospitable shores of Labrador and in the accidental fauna of the South Sea Islands. They reach even the highest regions of the north which have been trodden by man and the tops of the loftiest mountains, as far as the limit of perpetual snow. They are, however, very unequally represented in every distinct zoological province, and some of the minor groups are peculiar to one or more of such regions. The total number of forms now known cannot be far from ten thousand, and it is the most striking feature in their general distribution that the New World, whose area is so much less extensive than that of the Old, even in the tropical regions, contains about one-half of these species.

The species of butterflies are very unequally distributed among the four families which contain them. Thus the Nymphalidae embrace nearly forty-two per cent of the whole number, while the Papilionidae contain only about fifteen per cent. The Lycaenidae are next most numerous with nearly twenty-seven per cent, followed by the Hesperidae with less than seventeen per cent. In the geographical distribution of even the larger groups there is considerable lack of uniformity. Thus while the Euploeinae, which comprise nearly one-fourth of all the Nymphalidae, occur in both worlds and especially in the equatorial regions, they are composed of a few major groups, the members of each of which are almost entirely restricted either to the Old or to the New World. South America of all regions in the world is the richest in butterflies, and it is distinguished by having one group of Euploeinae of which says Wallace "not a single species is found in either Europe, Asia, Africa nor even North America excepting Mexico." A single species, however, does occur in our southern borders. The group is largely restricted to the Amazons district which, we may remark in pass-

ing, is so prolific in butterflies that, as Wallace says, "we may consider it the headquarters of South American Lepidoptera." The other subfamilies of the Nymphalidae are very wide spread, and in general form the bulk of the butterfly fauna of temperate regions. The Libytheinae, however, are exceedingly poverty stricken in numbers, forming less than three-tenths of one per cent of all the Nymphalidae, but yet are distributed quite around the world, though generally confined to subtropical regions, extending, says Wallace, "on all sides in an erratic manner, into various remote and disconnected portions of the globe."

The most striking general feature in the distribution of the larger groups, however, is the almost exclusive restriction of the subfamily of Lemoniinae to tropical America, quite as prominent a fact as the similar limitation of humming-birds to the same region. The species of humming-birds are the smallest of their class and number nearly four hundred, or about four per cent of the known birds; they are exclusively American, and more than ninety per cent of them are confined to the tropics. The Lemoniinae are among the smallest of butterflies and number nearly eight hundred species, or about ten per cent of the known butterflies; of these only thirty species, or less than four-tenths of one per cent of the family are found in the Old World, and of the American species ninety-seven per cent are confined to the tropics. Only six humming-birds, and similarly but seven Lemoniinae, are known within the limits of the United States.

The Lycaeninae, which comprise nearly two-thirds of the members of the family of Lycaenidae, occur everywhere, but certain members of the same, such as the Theclidi, are found in infinitely greater abundance in the New World, especially in South America, than anywhere else. Among the Papilionidae, the Pierinae have about the same numerical relation to the Papilioninae that the Lycaeninae have to the Lycaenidae. They are about equally distributed between the Old and the New Worlds, and are well represented in temperate climes, as well as in equatorial regions. The Papilioninae on the other hand are more strictly equatorial, following this belt around the world. Less attention has been paid to the Hesperidae than to the other families and their numbers are perhaps far greater than we imagine. They swarm in the tropics, and a very considerable number are found in temperate regions of America, where indeed they form a very marked feature of the butterfly fauna, which is by no means the case to the same extent in the Old World. The highest family, or brush-footed butterflies, is, as we have seen, more numerous than any of the others, and though, like the others, it reaches its maximum of development within the tropics, its numerical superiority is most evident in temperate zones, and especially in the north temperate region of the Old World, where its numbers equal those of all the other families combined.

Many attempts have been made to divide the world into zoological

provinces and to show the distribution of great groups in each of these. But these great provinces rarely or never mark the separation of the more important groups of animals, such as the butterflies or the Lepidoptera as a whole, but only limit the distribution of minor groups within these great divisions. The butterflies, however, more perhaps than most other groups, emphasize the grand division of the world into two great areas, the Old and the New Worlds; and it is only where, toward the arctic regions, the great lateral extension of the land brings the continental masses into close juxtaposition, that we find any great similarity between the butterfly faunas of these two vast regions; and here in the nature of the case the fauna itself is most scanty. When we pass in the opposite direction to the southern continents, widely separated from each other by vast oceans, we find an almost total distinctness of fauna, so that a voyager from one to the other region would be instantly struck by the quite different aspects of butterfly life in the one region and in the other; and as South America is connected with the north by only a narrow peninsula, it stands as the most distinct and unique butterfly region of the world, and the complete or nearly complete confinement of some of the larger groups to this continent is in entire conformity with the physical facts.

Unfortunately, the study of the geographical distribution of butterflies is not aided, as is that of many other groups of animals, by the data of paleontology, but must depend entirely upon the knowledge of existing forms.

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CISSIA EURYTUS.—The little wood satyr.

[The dusky argus (Gosse); Eurytris butterfly (Harris); little wood satyr (Seudder); six-spotted quaker butterfly (Maynard).]

Papilio eurytus Fabr., Syst. entom., 487 (1775);—Abb., Draw. ins. Ga. Brit. mus., vi: 25, figs. 52-53. (1884);—Mayn., Butt. N. E., 6-7, pl. 2, figs. 7, 7a (1886).

Euptychia eurytus Butl., Proc. Zool. soc. Lond., 1866, 465 (1866).

Megisto eurytus Scudd., Syst. rev. Amer. butt., 7 (1872).

Cissia eurytus Scudd., Bull. Buff. soc. nat. sc., ii: 245 (1875); Butt., 297, fig. 254 (1881).

Papilio eurytris Fabr., Entom. syst., iii: 157 (1793);—Herbst, Natursyst. ins. schmett., viii: 96-97, pl. 196, figs. 7-8 (1796).

Hipparchia eurytris Harr., Ins. inj. veg., 3d ed., 306, fig. 129 (1862).

Neonympha eurytris Doubl., Catal. Lep. Brit. mus., i: 137 (1844);—Edw., Can. ent., x: 105-108 (1878);—French, Rep. ins. Ill., vii: 156 (1878); Butt. east. U. S., 238-240 (1885);—Middl., Rep. ins. Ill., x: 90 (1881);—Coq., ibid., 184 (1881);—Fern., Butt. Me., 68-70

Satyrus eurythris God., Encycl. méth., ix: 465, 494 (1819);—Boisd.-LeC., Lép. Amér. sept., pl. 61, figs. 1-4 (1833).

Neonympha eurythris Morr., Catal. Lep. N. Amer., 10 (1860); Syn. Lep. N. Amer. 73 (1862);—Saund., Can. entom., ii: 139-142, fig. 9 (1870).

Papilio cymela Cram., Pap. exot., ii: 55, 148, pl. 132, figs. C. D. (1779).

Neonympha cymela Ménétr., Catal. coll. entom. acad., i: 40 (1855).

Megisto cymelia Hübn., Verz. schmett., 54 (1816).

Figured by Petiver, Gazophylacium, pl. 3, fig. 3 (1695?);—Abb., Draw. Gray coll., Bost. soc. nat. hist., 54;—Glover, Ill. N. A. Lep., pl. 35, figs. 2-3; pl. A., fig. 25, ined.

The butterflies — bright airy things —
From off the lilac buds
I scared, for having on their wings
The shadows of the woods.

ALICE CARY.—*Tricksey's Ring*.

Imago (1: 8; 11: 6). Head furnished with long, blackish brown hairs, bordering the inner edge of the eyes, and partially embracing the base of the antennae; between them is a median row of equally long, pale or dull yellowish hairs, which, behind the antennae, expand into a transverse row and are followed posteriorly by mingled yellowish, brownish and greenish olivaceous hairs, all of them rather pale; the eye is edged posteriorly almost as far as the base of the antennae with pearly, backed especially above with blackish, mingled with ruddy scales. Palpi pearly, dotted with black externally at the very base, with a distinct black streak along the under portion of the inner side, the superior fringe pearly externally, black internally; the inferior fringe pearly internally, blackish externally; but next their base superimposed by shorter, pearly scale-hairs, which grow longer toward the base of the palpi; apical joint blackish brown, with a longitudinal stripe externally below and above, the latter tapering; fringe beneath of mingled black and white hairs. Antennae above blackish brown, interrupted rather broadly at the base of each joint with white, less distinct and marked above than on the sides, externally forming a continuous white stripe; beneath reddish orange, broadening apically so as to occupy the whole of the nuder surface, the sides and the sides of the upper surface of the club, besides the whole of the apical three joints. Tongue fusco-luteous, the middle of each maxilla fuscous; papillae (61: 27) long, apple-seed shaped, compressed, so as to appear equal in some views, with faint indications of four or five raised points around the apical rim, the central filament slender, and as long as the width of the papilla.

Thorax covered above in front with abundant, delicate yellowish and greenish olivaceous hairs, posteriorly with less profuse brownish olivaceous hairs; beneath with shorter, brownish yellow and sometimes pale, slightly olivaceous hairs. Fore legs covered with hoary hairs; others pale buff, the femora fringed pretty heavily with hoary hairs, and interiorly lined more or less with bluish scales. Spurs and spines fusco-luteous, the former scaled nearly to the tip. Claws reddish, a little dusky at the tips.

Wings above nearly uniform dark brown, slightly paler in the ♀. *Fore wings* crossed a little beyond the middle by an indistinct — more marked in the ♀ than in the ♂ — slightly curved, slender, dusky stripe, at its extremities curved more strongly outward, and crossing the middle median nervule at an interspace's distance from its base; the tip of the cell is sometimes indistinctly marked with fuscous; the outer border has a very narrow edging of blackish fuscous, followed almost immediately by another similar line and again, at less than an interspace's distance from the outer border, by a slightly broader, similarly colored, gently waving stripe; about midway between this stripe and the extra-mesial stripe, or a little nearer the former (the field itself being often, and especially in the ♀ and in faded specimens, slightly paler than the rest of the wing) are two round, black ocelli, one in the lower subcostal, the other in the lower median interspace, enclosing a pair of faint, bluish fuscous dots, one above the other; the black spots are rather narrowly but distinctly edged with pale yellowish, reaching the sides of the interspace; fringe uniform grayish fuscous. *Hind wings* crossed near the middle by a slender, indistinct, nearly straight stripe of fuscous, passing just beyond the tip of the cell; the outer border is marked just as in the fore wings, the inner submarginal stripe perhaps a little less wavy; there is also a similar ocellus in the lower median, which, owing to the breadth of the interspace, is frequently a little transverse, and in the lower subcostal interspace an obsolete one; occasionally there is a smaller, obsolete one in the upper subcostal interspace; fringe similar to, but generally a very little paler than, that of the fore wings.

Beneath rather pale gray-brown, very slightly tinged on the apical half with yellowish, and toward the base almost imperceptibly with greenish; the stripes of the upper surface are repeated beneath, a very little more broadly, those near the border in dark brownish fuscous, the mesial in dark yellowish brown. *Fore wings* with the ocelli of the upper surface repeated beneath, the double pupils of steel colored scales, the black of the same size as above, but the yellowish border twice as broad, extending, especially in the upper one, beyond the nervules; in addition there is another transverse stripe, similar and parallel to the mesial, but a little slenderer and fainter, situated midway between that and the base, and extending from the subcostal to the submedian nervule; in the interspaces between those occupied by the ocelli, and in a line with the latter, is a small, roundish spot of gleaming, light steel colored scales, broken in the middle by the fold of the wing which passes midway between the nervules; fringe paler than above. *Hind wings* having a straight, transverse stripe, similar and parallel to the mesial stripe, and situated midway between the latter and the base of the wing; a round or roundish black ocellus in both subcostal, the lower median and the medio-submedian interspaces, the corresponding ones opposed to those of the upper surface; that of the lower median interspace is largest, and usually somewhat or considerably transverse; that of the lower subcostal is next in size, while the other two are smaller and nearly equal, that of the medio-submedian occupying only the anterior half of the interspace, but never touching the one above it; while the upper two always touch and sometimes have their yellow bordering more or less blended; the ocelli are similar to those of the fore wings, excepting that the steel colored scales form a single instead of a double pupil in the upper and lower spots; in the subcosto-median and upper median interspaces, on a line with the ocelli of the other interspaces, is a pretty large spot of light steel colored scales somewhat scattered toward the outside, and varied here and there by blackish scales; the spots are broken in the middle as in the fore wings; fringe as in fore wings.

Abdomen above blackish brown, enlivened with pale brown hairs; beneath rather pale grayish brown. Male appendages (33: 6, 7): upper organ arched a little longitudinally; hook a little arched at extreme base, beyond taking the direction of the posterior half of the centrum, rather high at the base, tapering regularly almost to the tip, more than four times as long as high and half as long again as the centrum; the inferior foliation extending from the middle of the basal half nearly to the tip, regularly ovate, fusiform, two and a half times longer than broad, the tip minutely hooked beneath; lateral arms very slender, tapering very slightly, finely pointed, as long as

the hook, somewhat arched and curved a little inward, the apex directed downward. Clasps broad at the base, three times as long as broad, rapidly tapering from just before the middle to the middle of the outer two-thirds, by the upward sloping of the lower margin, while the latter is at the same time slightly arched, the apical third not one-quarter the width of the base, equal but pointed at the tip, where it is strongly incurved and armed with a few scarcely perceptible prickles; there is a slight lateral inward expansion of the upper edge, just before the apical third of the clasp.

Measurements in millimetres. Length of tongue 5.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	18.	19.75	20.75	19.	20.	21.
antennae.....	8.	8.25	8.75	8.	8.25	8.5
hind tibiae and tarsi.	5.5	6.	5.75	5.5	6.	6.35
fore tibiae and tarsi.	1.25	1.25	1.25	1.1	1.4	1.4

Secondary sexual peculiarities. For the androconia, see the generic description.

Egg (64: 5, 11). Very pale yellowish green, almost white; cells on the upper half averaging about .042 mm. in diameter, separated by raised lines .0085 mm. in width, the surface of the cells perfectly flat and pretty smooth; the micropyle is about .13 mm. in diameter, and the average diameter of the cells composing it is about .019 mm.; height, .9 mm., greatest diameter, .88 mm.

Caterpillar. *First stage (70:4).* Head (78:25) pale greenish castaneous, the ocellar spot dusky; mouth parts pale, hairs dusky. Body pale brown with a greenish tinge, the dorsal, lateral, stigmatal and suprastigmatal stripes roseate, or yellowish brown with a pinkish hue; suprastigmatal stripe broader than the others which are equal and slender. Legs and prolegs concolorous with body; spiracles pale, with a fuscous annulus; hairs (86:40) pale brown, paler at clubbed tip. Length 3.5 mm.

Second stage (78:26). Head rounded subquadrate, broadest at upper limit of eyespecks, with tubercles as in first stage but proportionally smaller; color pale watery brown, narrowly banded, longitudinally behind and above, transversely in front, with very pale yellowish brown, which is the color also of the coronal tubercles; the scattered tubercles are pallid and give rise to mingled pale and black hairs; the sutures are marked in rust-brown, the ocelli are black; labrum black edged; mandibles edged with castaneous deepening to black; antennae pale yellowish brown with a long colorless bristle. Body dull and rather pale green, studded with small pallid tubercles (86:42) of two sizes, one about three times as large as the other, arranged in transverse rows, each giving rise to a short, pale or dark hair, and adorned with longitudinal stripes corresponding exactly to those of the first stage; viz., a dorsal dark olive green stripe deepening to purplish brown posteriorly; a very slender, lateral, reddish brown line edged below with yellowish, which extends upon the sides of the caudal forks, and below scarcely separated stigmatal and substigmatal bands of same color, the latter edged beneath at the fold with yellowish. Caudal forks as long as the last segment. Stigmata minute, blackish. Length, 6.5 mm.; breadth of head, .85 mm.

Third stage (78:27). Differs from preceding stage only in size, the length of the caudal horns, and the slightly intensified coloring and contrasts of the bands. Length, 8.5 mm.; of caudal horns, .4 mm.; breadth of body, 1.4 mm.; of head, 1.5 mm.

Fourth stage (74:13). Head (78:23) pallid, blotched with dull brown, there being a broad diverging band on either side of the triangle, reaching as high as it by its outer and higher edge, a narrow transverse belt uniting the coronal tubercles and broadening in the middle between them; and midway between these two, on the face, a narrow, transverse, zigzag or deeply lunate belt, which encircles the head and becomes straight on the sides, separated from it by a narrow pallid patch; the lower portions of the sides are wholly infuscated, like the upper half of the triangle. The whole head is studded with larger and smaller, conical, white tubercles, from each of which springs a short black hair; the moderately large and distant coronal tubercles are ferruginous; ocelli luteous edged posteriorly with black; jaws white at base, blackish castane-

ous on cutting edge; antennae and spinneret pale. Body dull and pallid greenish yellow, heavily besprinkled with high, conical, pallid tubercles, each bearing a short, brown hair. There is a broad, blackish brown dorsal stripe, narrowest on thoracic joints, a similar stigmatal stripe, but discontinuous, being made up entirely of disconnected dots, and so far less conspicuous; a very faint, pale ferruginous, lateral stripe, deepening at the extremity of each segment into a distinct spot, becoming blackish brown on the middle segments; and a much broken, suprastigmatal, blackish brown stripe, continuous only on the thoracic segments, and there but partially, and beyond conspicuous only by a short bar on the front of the segments in which the lateral dots are distinct. Caudal horns a little larger than the last segment, and like it pallid externally, infuscated within, and besprinkled with pallid tubercles. Under surface of body next the stigmatal fold besprinkled with blackish dots. Legs of body color, the claw tip infuscated; prolegs very pale, pinkish apically. Spiracles black, centrally encircled with pale and this with a narrow fuscous ring fading out below. Length soon after moult, 11.5 mm.; width of head, 1.8 mm.; of body, 1.6 mm.; length, when nearly ready to change, 16 mm.; breadth of body, 2.5 mm.

Last stage (74: 3, 6, 10). Head (78: 29) sordid white, heavily mottled with dark brown in irregularly margined transverse bands and blotches, which are everywhere interrupted by dots of the basal color; these dark parts are especially noticeable as bands in a transverse line uniting the summits of the two hemispheres, in a broad band subparallel to and but little distant from the facial triangle, and in a large, triangular spot occupying the upper part of this triangle; besides these the other blotches form vague longitudinal bands crossing the cheeks; but in some specimens the whole front of the head is almost uniformly fuscous but dotted with sordid white. In particular in all cases the numerous papillae are pallid and give rise to delicate black hairs, several times their own length; ocelli ruby-black, piceous at ground; mandibles pale testaceous at base, rapidly changing through testaceous to black apically; antennae and other mouth parts testaceous. Body pallid brown with a slight greenish tinge, completely studded with minute, pallid, conical tubercles, infuscated at the tip and bearing reddish testaceous acicular spines nearly as long as themselves. The markings of the body are: first, a median, blackish stripe, fainter and nearly reduced to its edges on the thoracic segments, deepening to almost inky blackness (when most intense) on the hinder abdominal segments, and throughout intensified at the extremity of the segments; second, a suprastigmatal series of large, roundish, fuscous spots of greater or less depth of color just in front of the middle of each segment, tending to become oblique patches, whose hinder edge passes just over the spiracles; third, a narrow, pale, sinuous lateral stripe on the abdominal segments, consisting of a single arch to each segment, margined below and above with dark olivaceous brown, broadest and more uniform but only conspicuous on the posterior half of each segment below, almost entirely reduced to a still deeper spot at the posterior extremity of each segment above; the whole faintly traceable on the thoracic segments; fourth, of a fuscous edging of the substigmatal fold; fifth, a narrow fuscous ventral stripe, most distinct on the apodous segments; and sixth, a fuscous lateroventral spot near the anterior edge of all the segments. Caudal horns almost wholly sordid white, infuscated along the median line above. Legs pale greenish; claws testaceous; prolegs color of body; circlet of hooks roseate testaceous; spiracles black encircled with pallid. In some specimens, the markings and especially all but the dorsal stripe are very much subdued, and the greenish tone of the whole is then more distinct; but in all, the thoracic segments are more or less griseous and with small sign of the markings. Length, 21 mm.; breadth of head, 2.6 mm.; of neck, 1.5 mm.; of third abdominal segment, 3.75 mm.; length of caudal horns, .8 mm.

Chrysalis (83: 28). Brownish pallid, heavily flecked with griseous, especially on the apical half of the abdomen, the head, and the visible parts of the hind wings; more than usually pallid on the first three (dorsal) abdominal segments; all the carinae, of head, wings, mesothorax and abdomen, white; wing-veins pallid; cremaster griseous on the sides, castaneous at tip, the hooks castaneous; spiracles luteo-fuscous, with

pallid lips and a griseous areola. Posterior edge of the dorsum of the first five abdominal segments notched in the middle. Length, 10.5 mm.; height, 5 mm.; width, 5 mm.

Distribution (18:8). This insect appears to be almost exclusively confined to the United States east of the great plains, and nearly everywhere is spoken of as abundant. It occurs all along the Atlantic coast, even to southern Florida where, at Haulover, Mr. Schwarz has taken it; on the Gulf side Dr. Chapman finds it plentiful at Apalachicola, Gosse records it from Alabama, and Strecker from Texas; it is profusely abundant in Iowa (Allen, Austin, Osborn, Putnam), occurs also rarely in eastern Kansas (Snow), is reported from Fort Niobrara, Neb. (Carpenter) and is common in Wisconsin (Hoy). Mr. Harrington says it is not common in southern Michigan, but Mr. Saunders finds it plentiful in Ontario, where Lowe reports it in Essex Co. It occurs elsewhere north of our border in Quebec (Fyles), Montreal (Caulfield), Ottawa, common (Billings, Fletcher), and at Sudbury, north of Georgian Bay (Fletcher).

In New England it is found in all the southern and middle portions, but is absent from or rare in the northern. The most northern points known to me are Walpole (Smith), Plymouth, common (Scudder) and Milford, N. H. (Whitney); Norway, Me., where Mr. Smith found it in abundance, Brunswick (Packard) and Portland, Me. (Lyman). It does not occur in the White Mountains, although Hill records it from the Adirondacks, but probably will be found close to their southern boundaries, and quite as far north in Vermont. In the southern part of New England it is exceedingly abundant.

Haunts. The butterflies of this species frequent tall thickets and groves, the border of open woods and partially shaded forest roads. Mr. Saunders says: (Can. ent., ii: 139) "they delight in the sunny openings found oftentimes in partially cleared woods, also in wooded lanes and roads and the sunny edges of the forest, where by their peculiar jumping flight they may be readily recognized, sometimes singly, at other times sporting in twos and threes"; to us, however, they seem usually to prefer more shade than this extract would seem to imply.

Oviposition. The eggs are laid singly on blades of grass, living or dead. Observation has been made only upon imprisoned females. Mr. W. H. Edwards found them "laid upon the grass, or dropped loosely upon the sod or the earth." Of fourteen laid for me by one individual, only five were laid on living blades, the remainder upon dead blades close to the ground. Those upon the living blades were all laid on the under surface, whether prominent as everywhere excepting near the tip, or flat as near the tip. They are slightly attached at indifferent heights from the ground, the smaller blades of grass being apparently preferred. The duration of the egg state is about thirteen days in the north, only eight days in West Virginia.

Food plant. The caterpillar, which has never been obtained in the open field, feeds freely upon any ordinary grass. It is figured by Abbot upon *Xyris torta*. Some eggs were once laid for me on the under side of leaves of clover.

Habits of the caterpillar. My first acquaintance with the early stages of this insect was through the late Mr. P. S. Sprague, who, like Mr. Saunders, whose experience is related in the *Canadian Entomologist*, succeeded in carrying the caterpillar only up to the time of hibernation. His observations show that while young they eat only the edges of blades of grass and move about but little, a character which seems universal among the Satyrinae; when larger they frequently bite off whole blades of grass above themselves and devour the end of the standing blade; marks of their feeding are seen in the scattered tips lying on the ground; they feed only by night, lying concealed by day among the roots of the grass, sometimes on dead sticks, which they much resemble; they are shy, usually dropping to the ground at the least disturbance; their movements somewhat resemble those of the Geometrids; they eat meagrely and therefore grow slowly, only attaining the length of half an inch before cold weather, when they seek a hiding place and sleep through the long winter.

Since then, I have repeatedly reared the insect, and have sometimes succeeded in carrying it through the winter. So, too, has Mr. Edwards. He writes (*Can. ent.*, 10 : 107) :

The earlier stages were rapidly passed, but the last were very much prolonged. When about to moult the larvae remained for three or four days before this event motionless, and as many after, and there were periods of several days between the moults when they rested and took no food. . . . The larva is sluggish at all times, moves very little and with great deliberation. . . . Soon after the third moult, the larvae all ceased feeding, and some appeared to be in profound lethargy; but others, after resting for several days, would arouse and eat a little, then sleep again; but every one, notwithstanding the lethargic condition, was found to have changed its position several times.

My experience has varied slightly from this, for I have found the caterpillar sluggish at all times, and while the first moult was passed in West Virginia in a week, this stage lasted more than two weeks in Massachusetts, and in three weeks thereafter the third moult was passed; the fourth stage, however, is always very much prolonged, being generally fully three weeks in duration. During the first and second stage it feeds both by day and by night, resting after feeding wherever it happens to be, extending its body along the blade of the leaf, sometimes with the head uppermost, sometimes downward, and when feeding nibbles only the edges of the grass, as observed by Mr. Sprague. Its movements are astonishingly slow, almost as difficult to see as the motion of the minute hand of a clock. After the second stage is passed it feeds only by night, and rests only on the stems and not on the blades, retiring generally to the very foot of the stalk, and pushing its way headforemost as far as it can go down to the

base of one of the blades, turning back to feed again toward sundown. In resting, the caudal horns are nearly horizontal, but are a trifle raised.

One which was overtaken by winter, after it ceased to eat wandered slowly for several weeks—though remaining motionless most of the time—in the search for a suitable place to hibernate; finally about November 7 it took a position near the base of a bundle of leaf-stalks where a dead blade from another cluster overhung it, spun a single thread across to unite the two, and stationed itself head upward for the winter. Another took up its station on the base of a blade of grass about October 20 and remained here, in the living room of a house until January 26, when it aroused and began regularly to eat by night, and to hide, as above described, by day.

Pupation. The caterpillar spins a web on a blade of grass just where it has been feeding or without wandering far, hangs in a very strongly curved position for three days before casting the larval skin, and then hangs as a chrysalis for about sixteen days in the north, eleven in the south.

Life history. There is only one brood annually. The butterfly appears in the extreme south of New England about the 20th of May; in the vicinity of Boston usually at the close of the month or the very first of June; it remains common throughout June, seldom much longer, but occasional specimens may be taken far into July; and I once captured a specimen in Waltham on August 3. Mr. Saunders states that in Ontario it usually appears about the 10th or 12th of June, though sometimes as early as the 1st. Its ordinary appearance can hardly be delayed until the second week of June, but it may be that it varies greatly, according to the season, for Dr. Packard writes that it appeared one year at Brunswick, Me., as late as the 23d of June. In the extreme southern states it makes its appearance the last week of March, and continues through April into May (Chapman); Mr. Schwarz took it at Haulover, Fla., on March 16.

The above account is substantially as I wrote it fifteen years ago, and there would be apparently no occasion to change it now for the vicinity of Boston; but elsewhere, both north and south, fresh specimens have been taken much later in the season. Mr. F. H. Sprague, in particular, writes me of his experience in 1885, and he has observed similar occurrences in other seasons, that in eastern Massachusetts "very few good specimens were met with after the middle of June, and by July 1, they had altogether disappeared with the exception of perhaps a dilapidated one here and there"; while "in the hilly region of the Connecticut Valley (in central Massachusetts) fresh specimens of the male were taken sparingly from July 6-10," not accompanied by a single female nor by any worn specimens, and for the next three days several more good and fair specimens of both sexes but none poor. Later than this, in other years, faded specimens were taken in the same region until after August 1. Captain Geddes also reports taking the species in Canada in September, and Mr. Edwards says

that "fresh butterflies" . . . are flying here [W. Va.] in the fall." He also reared one to imago from eggs of the same year, and I have done the same in Cambridge, though in my case it was in the house and the caterpillar did not change to chrysalis until October 13.

The caterpillar is, however, so very sluggish in its movements and, under favorable environment, plenty of food and protection from the inclemency of the weather, takes so long to undergo its changes (normally hibernating in New England, to judge from the experience in several seasons, in the last larval stage), that it seems quite impossible that the fresh July butterflies noted by Mr. Sprague could have come from eggs of the same season. The insect must be single brooded. It seems rather more probable that some caterpillars overtaken by the cold season in their penultimate or even a preceding stage, reached their development at a correspondingly later period the following year; but why these should appear after their more steady companions had had their season and disappeared is a question to be solved, and the species will bear a good deal of experimental study before this can be determined. It would seem as if this July brood were an accidental offshoot trying to perpetuate itself, and by the necessities of the case breeding in and in, and taking like the alternate brood an entire year for the completion of its cycle.

The normal continuance of the species in New England after the flight of the May-June butterflies is as follows: the butterfly lays its eggs in the latter half of June, all that I have seen between June 20 and 25, and they hatch as above stated in about 13 days. The caterpillar grows slowly to at least its penultimate stage and often nearly to maturity before hibernating, feeds more or less in early spring and changes to chrysalis in May, when the butterflies appear again.

Flight and posture. This shade-loving butterfly has a dancing flight, skipping here and there with careless grace and ceaseless movement about three or four feet above the ground, disappearing among the foliage and anon reappearing, so that one loves to stand in the quiet wood, watch its fanciful movements, and dream that fairies float on butterfly wings.

Eurytus walks, as it flies, by a succession of spasmodic little starts. When at rest upon a horizontal surface the body is elevated anteriorly at an angle of about 25° and the wings are closed back to back, so that the inner margin of the fore wing just reaches the upper submarginal spot on the superior surface of the hind wing. The antennae spread at an angle of 80° and are raised at an angle of about 25° with the body; they are not straight, but curved at the base a little upward and forward, and at the tip about as much downward and forward and also very slightly outward; the position of the antennae is the same during motion.

Desiderata. By far the most important point for study in the history of this butterfly, all of whose stages are known, is to solve the problem of

the appearance in certain places of a late brood of butterflies. This brood is always scanty in numbers (while the June brood is abundant) but whether it is confined to special places or not, whether it is a regularly recurring or a chance phenomenon is unknown. Watching the behavior of considerable numbers of caterpillars—in this species a tedious undertaking—and perhaps experimenting on them under various favorable and unfavorable conditions; and particularly observing the variations in their condition at the approach of winter may perhaps be the best means of attacking the problem. But those who live in southern localities, where, in Mr. Edwards' opinion, the species is double brooded, may perhaps be in the best position to experiment. The northern distribution of the species in New England requires to be determined, and no parasites are known.

LIST OF ILLUSTRATIONS.—*CISSIA EURYTUS*.

<i>General.</i>		<i>Chrysalis.</i>	
Pl. 18, fig. 8.	Distribution in North America.	Pl. 83, fig. 28.	Side view.
<i>Egg.</i>		<i>Imago.</i>	
Pl. 64, fig. 5.	Plain.	Pl. 1, fig. 8.	Male, both surfaces.
11.	Part of surface greatly enlarged.	11: 6	Both surfaces.
	<i>Caterpillar.</i>	33: 6, 7.	Male abdominal appendages.
Pl. 70, fig. 4.	Caterpillar at birth.	38: 3.	Neuration.
74: 3, 6, 10.	Full grown caterpillar.	46: 4.	Androconium.
13.	Penultimate stage of caterpillar.	52: 3.	Side view of head and appendages enlarged, with details of leg structure.
14.	Full grown caterpillar enlarged.	61: 3.	Neuration, front wing of male.
78: 25-29.	Front view of head in stages i-v.	4.	The same of female.
86: 40.	Dermal appendage of caterpillar, first stage.	11.	Front view of head, denuded.
42.	The same, second stage.	27.	Papilla of tongue.

SUBFAMILY NYMPHALINAE.

Nymphalinae Bates; Nymphales Fabr.; Nymphalides + Peridromides + Biblides Boisd.; Nymphalites + Argynnes + Peridromites + Biblites Blanch.-Brullé; Nymphalidae + Peridromidae Doubl.; Nymphalides Herr.-Sch.; Nymphalidae + Ageronidae + Eurytelidae Doubl.-Westw.; Nymphalina + Eurytelina + Elymnina + Biina Herr.-Sch.; Nymphalinae + Elymninae Kirb.; Najades + Dryades + Hamadryades Borkh.; Najades Seudd. Consules (pars) + Nobiles Herbst. Spinigeri Newm.

Their wings with azure, green, and purple glossed,
Studded with coloured eyes, with gems embossed,
Inlaid with pearl, and marked with various stains
Of lively crimson through their dusky veins.

MRS. BARBAULD.

Champêtres divinités
Faunes, Dryades, sortez
De vos paisibles retraites.

MOLIERE.

Imago. Butterflies usually of medium or large size. Head quite variable in size. Front generally moderately tumid, more or less protuberant beneath. Antennae inserted in distinct pits, between which the union of front and vertex is almost always lower than the neighboring parts; consisting of from thirty to fifty joints, moderately slender, straight, scaled, considerably longer than, sometimes nearly twice as long as,

the abdomen, the club distinct, usually pretty long and not very broad; palpi rather stout, tufted pretty heavily with scales and hairs.

Thorax usually pretty stout, not compressed, the upper surface well rounded, not greatly elevated; anterior sides of mesoscutellum slightly hollowed, together forming a right angle; posterior border bluntly angulated at a little more than a right angle; metascutellum very inconspicuous, formed of a triangular piece facing posteriorly, the apex only appearing above and rounded; metascuta well developed, moderately tumid.

Fore wings usually produced to a considerable degree at the apex and generally more or less emarginate along the middle of the outer border; seldom pointed at the tip, sometimes angulated. Costal nervure usually terminating about half way between the tip of the cell and the outer border; two superior subcostal nervules usually emitted before the tip of the cell, the other two subsequently; first inferior subcostal nervule arising very close to the principal vein; the second at a variable distance below this, from the branch which helps to close the cell; discoidal cell less than half the length of the wing, sometimes open, but usually closed above by strong, below by slender veins; median nervules equidistant, the first arising not far from the middle of the cell, the last curving toward the subcostal nervure; internal nervure wanting.

Hind wings rounded or angulated, the outer border often crenulate or tailed; inner border always affording a gutter for the reception of the abdomen. Costal nervure terminating at the upper outer angle of the wing; lower subcostal nervule curving at base toward the median; discoidal cell either entirely open, or closed by a delicate vein, uniting the basal curving portion of the last subcostal nervule to the origin of the middle median nervule, directed outward from the subcostal toward the median nervure; the base of the last median nervule curving toward the subcostal beyond the cell; submedian nervure terminating at the anal angle; internal nervure terminating near the middle of the outer half of the inner border.

Fore legs greatly atrophied in the male, less so in the female; in the former the tarsi consist of a nearly or quite undivided joint, unarmed, although sometimes terminated by a single conical projection having the semblance of a spine, but in reality forming a joint; in the female, composed of five joints, all but the last furnished at the tip beneath with a pair of short spurs; claws of moderate size, falcate; paronychialia and pulvillus usually present.

Male abdominal appendages much stouter than in the Satyrinae; upper organ of variable size, never provided with lateral appendages, the hook and centrum generally of equal length. Clasps large, broad and tumid, seldom tapering much apically, furnished with an upper apical or basal process, emitted from the edge or the outer surface, and often with an upward directed, free or attached finger on the inner side of the clasp.

Egg. Either subglobular and then reticulate and filamentous; or barrel-shaped, distinctly higher than broad and then vertically ribbed, the ribs usually higher near the summit than on the sides, and sometimes confined to the upper half. There seem to be no characters here not shared with other subfamilies of Nymphalidae.

Caterpillar at birth. Usually furnished with long hairs arising singly from a moderate number of warts, distributed over the body in regular, longitudinal rows, but sometimes with very short hairs arising from very frequent, regularly distributed warts.

Mature caterpillar. Head furnished with long hairs arising from scattered warts, or with elongated spiniform tubercles. Body nearly cylindrical, rarely not distinctly moniliform, equal or tapering behind, or sometimes in front; or if swollen unusually in any part, such prominence is restricted to single segments and is never massed in two or more adjoining segments. Body either (infrequently) pilose or armed above the spiracles with from three to seven longitudinal rows of spines or conspicuous tubercles, and below the spiracles with one or two additional rows on either side; terminal segment occasionally bifid, but usually with a large, but not greatly elevated posterior median tuberosity. Body either striped longitudinally, or with slender transverse bands at the extremities of the segments, or blotched with small, generally irregular markings, having a tendency to a linear longitudinal arrangement.

Chrysalis. Head more or less prominent, usually bifid in front. Thorax large, angulated at the base of the upper wings and with one or more prominences upon the mesothorax; the medio-dorsal line always more or less prominent near the middle of the mesothorax; posterior and superior margin of the wings prominent or considerably thickened, the lower surface nearly straight, with a very broad and regular longitudinal curve. Abdomen tapering pretty regularly and generally about uniformly toward the tip; broadest at and about the third segment, so that the border of the wings is raised more opposite this point and a broad, and deep or shallow curve follows their course to the base; furnished, particularly on the upper surface, with a greater or less number of prominences, either placed singly or in longitudinal series; cremaster usually rather long, at least equal to one of the abdominal segments, broad at base and tapering (excepting in *Chlorippe*).

This is the most extensive subfamily of butterflies and embraces an almost infinite variety of forms in every stage of its existence. With comparatively slight variation in the neururation of the wings, their outline and ornamentation present such wide diversities as to render any single description impossible. The same may be said of the earlier stages; and yet the assemblage united under this name is unquestionably natural and ordinarily accepted, excepting that portions are often split off from the main body by different naturalists.

The flight of the butterflies is usually strong and as a rule they love the sun and are seen most abundantly at midday. Fulvous and deep brown are the prevailing shades on the upper surface of the wings, at least in species from the temperate zones. Thwaites, speaking of the Indian species, says (Moore, *Lep. Ceylon*, i: 26-27):

The strength and firm texture of the wings of the butterflies of this subfamily enable them to keep up an unceasing activity during the bright hours of the day. They seem to delight in displaying their exquisite beauty to the sun, coquetting with him untringly while his face shines ardently upon them. Their flight, though so powerful, is not observed to sustain these charming insects in one uniform direction, like the *Euploea*'s, but serves rather to enable them, when rambling in their frolic, to make wide sweeps within no very extensive area.

The insect usually passes the winter as a caterpillar or an imago, and, in the latter case, is perhaps occasionally accompanied by the chrysalis; in no known instance does the egg hibernate. The larvae all feed on angiospermous exogens but their habits differ widely. The following account of the pupation is given by Harris (*Inj. ins. veg.*):

Having finished eating, the caterpillar wanders about till it has discovered a suitable situation in which to pass through its transformations. This may be the under side of a branch or of a leaf, or any other horizontal object beneath which it can find sufficient room for its future operations. Here it spins a web or tuft of silk, fastening it securely to the surface beneath which it is resting, entangles the hooks of its hindmost feet among the threads, and then contracts its body and lets itself drop so as to hang suspended by the hind feet alone, the head and fore part of the body being curved upwards in the form of a hook. After some hours, the skin over the bent part of the body is rent, the fore part of the chrysalis protrudes from the fissure, and by a wriggling kind of motion, the caterpillar-skin is stripped backward till only the extremity of the chrysalis remains attached to it. The chrysalis has now to release itself entirely from the caterpillar-skin, which is gathered in folds around its tail, and to make itself fast to the silken tuft by the minute hooks with which the hinder

extremity is provided. Not having the assistance of a transverse loop to support its body while it disengages its tail, the attempt would seem perilous in the extreme, if not impossible. Without having witnessed the operation, we should suppose that the insect would inevitably fall, while endeavoring to accomplish its object. But, although unprovided with ordinary limbs, it is not left without the means to extricate itself from its present difficulty. The hinder and tapering part of the chrysalis consists of several rings or segments, so joined together as to be capable of moving from side to side upon each other; and these supply to it the place of hands. By bending together two of these rings near the middle of the body, the chrysalis seizes, in the crevice between them, a portion of the empty caterpillar skin, and clings to it so as to support itself while it withdraws its tail from the remainder of the skin. It is now wholly out of the skin, to which it hangs suspended by nipping together the rings of its body; but, as the chrysalis is much shorter than the caterpillar, it is yet at some distance from the tuft of silk, to which it must climb before it can fix in it the hooks of its hinder extremity. To do this, it extends the rings of its body as far apart as possible, then, bending together two of them above those by which it is suspended, it catches hold of the skin higher up, at the same time letting go below, and, by repeating this process with different rings in succession, it at length reaches the tuft of silk, entangles its hooks among the threads, and then hangs suspended without further risk of falling. It next contrives to dislodge the cast caterpillar-skin by whirling itself around repeatedly, till the old skin is finally loosened from its attachment and falls to the ground. The whole of this operation, difficult as it may seem, is performed in the space of a very few minutes, and rarely does the insect fail to accomplish it successfully and safely.

The butterflies of this subfamily are only less widely distributed over the globe than the *Satyrinae*. Some occur even in the arctic regions, though the proper metropolis of this and indeed every subfamily is found in the tropics. The New World is perhaps richer than the Old in species of this group. Out of more than thirteen hundred described forms, only six or seven are common to both hemispheres, and most of these belong to the arctic regions. The subfamily usually bears the same numerical ratio to the whole butterfly fauna in the temperate zone as in the whole world; but in the north temperate zone of the Old World the *Satyrinae* as well as the *Lycaeninae* play so conspicuous a part as to overshadow even this extensive group.

Mr. Bates, in his essay on the *Nymphalinae* of the Amazons (*Journ. ent.*, 1864, 175-212) offers some interesting considerations upon their position and relations. We cannot always agree with him, and especially in his depreciation of the value of characters drawn from the metamorphoses of these insects, but we take pleasure in transcribing the following general remarks on the haunts and habits of the Amazonian species :

The early states of the insects are much diversified, and it is the same with their haunts and modes of flight. A certain number of genera, belonging more especially to the *Argynnis* and *Vanessa* groups, such as *Colaenis*, *Agraulis*, *Euptoieta*, *Melitaea*, *Anartia* and *Junonia*, are seen only in open, sunny places, such as weedy plantations and the suburbs of towns and villages, or the borders of woods. These are never found in the shades of the forest, and the food-plants of their larvae are such as grow only in open semicultivated places. It is interesting, therefore, to find that the only Amazonian genera which are closely related to the *Argynnes* and *Vanessae* of our own country are such as inhabit a sort of localities that both regions afford, and not the great tropical forest which harbours the peculiar forms of South America. The

Melitææ of the Amazons are very small and plainly marked; indeed they cannot be compared for size and beauty of form and markings with our English *athalia* or *cinxia*, and, like these northern species, they frequent weedy and flowery places on the borders of woods, flying low, and having somewhat of the floating motion in their flight: unlike the insects of the *Vanessa* group, one only of which (*Junonia lavinia*) is found in the Amazons region; for these are irregular in the motions of their wings, and settle frequently. *Euptoieta hegesia*, the only butterfly of the Amazons region that has a near resemblance to the *Argynnes* of Europe, inhabits the undulating meadow-districts of the country which lie near the middle part of the lower course of the river, and is never seen in the true forest-districts. This species, which is about the size of *Argynnis lathonia*, flies about the lower herbage and flowering bushes in the same way as our British *Argynnes*. There are two other Amazonian genera, *Anartia* and *Libythina*, which accompany the *Argynnitæ* and *Vanessitæ* in their grassy haunts; but these generally prefer the marshy meadows on the banks of rivers.

The rest of the Amazonian *Nymphalinae* are denizens of the great forest, and nearly all of the genera, as before remarked, are peculiar to tropical America; being creatures of the humid and luxuriant sylvan domain which spreads over all the river-valleys, and extends in most parts of the region far up the slopes of the mountains, skirting everywhere the margins of rivulets and torrents. One only of these genera is found in Europe, namely, *Apatura*, two species of which, inferior to our purple Emperor in size and beauty, inhabit the banks of the Amazons. If we except the genus *Eresia*, the species of which are no other than *Melitææ*, with wings lengthened after the manner of their inseparable companions, the *Heliconii*, and which hover about low shrubs in the shade of the forest, the remainder of the *Nymphalinae*, exclusive of the *Morphitæ*, may be classed, as respects their habits, into five groups. The first comprises a series of genera and species which resemble our *Apatura iris* in manners and style of flight. These live in the crowns of the forest-trees, and descend only to the ground in sunny places to suck the moisture from mud, moist sand, or ordure on the forest-pathways, or the margins of pools and streams. But it is the males almost exclusively that have this latter habit, the females remaining in the forest, where their mates join them, after their summer day's separation, in the afternoons when the sun is getting low. The males in very many of these species are much more brightly coloured than the females, and appear to be much more numerous. In some places, during the fine season (August to October), they assemble by hundreds, sometimes thirty or forty species together, of the most varied shapes and colours, to sport about in muddy places exposed to the morning sun. *Catagrammæ* and *Callitheæ*, with liveries of velvety crimson and black, or sapphire and orange; *Eunicæ*, with purple hues glancing in the sunlight as they fly; swallow-tailed *Timetes* of many species; silky-green *Eubages*; blue, white, and black *Megistanes*, tailed like the *Charaxes jasius* of Europe, and many other kinds less conspicuous in colour and form, are all seen together, either settled on the ground or swiftly flying to and fro above it. If the day becomes cloudy or windy, the sensitive creatures gradually betake themselves to the shelter of the neighbouring forest. Warm, calm, gleamy weather seems the most favourable to their appearance in the open places, a few females sometimes venturing from the forest at these times to join the company.

The second group is formed by such species as, having similar habits to those of the first group, never, or very seldom, leave the forest. Most of the richly coloured *Epicaliæ* belong to this category, and also the *Temenes* and others. These have, like many of the preceding, a rapid and irregular flight, the males settling for a few moments at a time on foliage where a ray of sunlight pierces the shades. The third group consists of species allied to the *Limenites* of Europe, such as the *Heterochroæ*, many kinds of *Eubagis*, the *Pyrrhogyræ*, and others, all of which fly about the lower trees in thinned parts of the forest, and have a floating, partly horizontal, and wheeling flight. If they are disturbed when settled on a leaf near the ground, they wheel round in flying off and settle on a higher place, and so on, until they are out of reach. The fourth group, also shade-lovers, are such as settle only on the trunks of

trees; these are the Gyneciae and Callizonae, which hold their wings erect in repose, the Ectimae and Pandoraae, whose wings are partly open, partly closed, when they settle, and the Ageroniae, which extend their wings flat on the trunks of trees. These latter are most peculiarly coloured, and differ much from all other Nymphalinae in their habits, as will be familiar to all readers of travels in Brazil. Lastly, the fifth group is composed of numerous genera and species closely related to our purple Emperor, which also live habitually in the forest, but have a most rapid flight, and settle frequently on outstretched branches or foliage. They are all bold creatures, not moving from their perches until driven off, and, even when scared away, returning to them after a few minutes' absence, dashing meanwhile with arrowy swiftness along the forest-alleys. Such are the species of Agrias, the most beautiful genus in the whole subfamily; the Preponae, the Siderones and the Paphiae, of all of which there are numerous species in the Amazons region, some of them extremely common.

Out of the sixteen known forms of fossil butterflies, six belong to this subfamily, five of them from American deposits.

Table of tribes of Nymphalinae, based on the egg.

Sides reticulate, with filamentous projections.....	Nymphalidi.
Sides vertically ribbed above, without filamentous projections.	
Ribs extending from base to summit of sides.	
Egg broadly domed above, the summit not greatly narrower than the base; ribs generally with a very direct course.	
Ribs not very elevated, of about equal height throughout the egg....	Apaturidi.
Ribs strongly compressed, prominent, much higher on upper than on lower part of egg.....	Vanessidi.
Egg rapidly narrowing in upper half, so that the constricted and subtruncate top is very much narrower than the base; ribs with rather an uncertain wavy course.....	Argynnidi.
Vertical ribs wanting on basal third or half of sides.....	Melitaeidi.

Table of tribes, based on the caterpillar at birth.

Hairs of body short, not longer or scarcely longer than segments.	
Ranged papillae of body inconspicuous, equal.....	Apaturidi.
Ranged papillae of body conspicuous, unequal.....	Nymphalidi.
Hairs of body long, very much longer than segments.	
Course of ranged papillae distinctly shifted in position at the division line between thoracic and abdominal segments; hairs not spiculiferous.....	Vanessidi.
Course of ranged papillae not shifted or scarcely shifted in position throughout; hairs generally spiculiferous.	
Hairs delicately tapering, but slightly enlarged at the extremity.....	Argynnidi.
Hairs delicately tapering throughout, finely pointed.....	Melitaeidi.

Table of tribes, based on the mature caterpillar.

Body simply pilose, the hairs arising from papillae innumerable.....	Apaturidi.
Body armed with spines or tubercles, with only scattered papillae.	
Body hunched, furnished irregularly with denticulate or stellate tubercles...	Nymphalidi.
Body uniform, furnished with uniform or very nearly uniform series of horny or coriaceous spines.	
Spines horny, armed on the sides with scattered needles, and terminating with a distinct and independent thorn, slightly smaller at base than the apex of the spine proper.	
Some of the spines arranged in a mediodorsal row (occasionally reduced to a single spine or a mere lenticular wart, found only on the seventh or eighth abdominal segment); lateral needles of spines often mounted on prominent spinules.....	Vanessidi.
None of the spines arranged in a mediodorsal series; lateral needles of spines mounted on slight papillae only.....	Argynnidi.
Spines coriaceous, armed on the sides with crowded needles, no apical one holding a distinctly independent position.....	Melitaeidi.

Table of tribes, based on the chrysalis.

Head projecting independently beyond, and distinct from, the thorax.

Base of wings with only a single tubercle.

Mesonotum with no special median prominence.....**Apaturidi.**

Mesonotum with a prominent, median, compressed tubercle.....**Nymphalidi.**

Base of wings with a pair of tubercles, the second directly below the highest point of mesonotum.

Cremaster long, slender, tapering.....**Vanessidi.**

Cremaster short and stout.....**Argynnid.**

Head forming a single mass with the thorax.....**Melitaeidi.**

Table of tribes, based on the imago.

Antennal club long and slender, hardly more than twice as broad as the stalk, gradually incrassated.

Club with three inferior carinae; precostal nervure of hind wings arising beyond the parting of the costal and subcostal nervures; two rows of spines on under side of last tarsal joint; clasp of male abdominal appendages with no interior finger.....**Apaturidi.**

Club with four inferior carinae; precostal nervure of hind wings arising opposite the parting of the costal and subcostal nervures; four rows of spines on under side of last tarsal joint; clasp of male abdominal appendages with an interior fluger.....**Nymphalidi.**

Antennal club short and stout, three or more times as broad as the stalk, more or less abruptly incrassated.

Club with three distinct and complete carinae; second superior subcostal nervure of fore wing arising before the tip of the cell; two rows of spines on under side of last tarsal joint (excepting *Vanessa*, which has four); last fore-tarsal joint of ♀ armed with a pair of spurs; male abdominal appendages closely concealed by the terminal segment.....
Vanessidi.

Club with only a single complete carina, or none; second superior subcostal nervure of fore wing arising at or beyond, rarely before, the tip of the cell; four rows of spines on under side of last tarsal joint; last fore-tarsal joint of ♀ unarmed; male abdominal appendages exposed.

Club subspatulate, about twice as long as broad; palpi large and bushy, the last joint extremely short; tibiae and tarsi clothed with spines above; upper organs of male abdominal appendages large.....**Argynnid.**

Club about three or four times as long as broad; palpi long and slender, compact, the last joint from half to a third as long as the middle joint; tarsi destitute, and tibiae nearly destitute of spines above; upper organ of male abdominal appendages small.
Melitaeidi.

TRIBE APATURIDI.

EMPERORS.

<i>Apaturides</i> Boisduval; <i>Apaturidae</i> Newman;	<i>Argonautae</i> Cramer.
<i>Apaturae</i> Butler.	<i>Thysanuriform stirps</i> (pars) Horsfield.
<i>Papiliones versicolores</i> Wiener Verzeichniss.	<i>Paphianae</i> Swainson.

Above the sovereign oak, a sovereign skims.
CRABBE.

Imago Head: club of antennae generally long, but pretty clearly marked, slightly depressed, with three inferior and interior carinations on the naked portion. Palpi moderately slender with compact vestiture, together forming a conically pointed beak; terminal joint very small.

Thorax: second superior subcostal nervure of fore wings sometimes arising before, sometimes scarcely beyond, the tip of the cell, the base of the third sometimes carried far back; cell open or closed; when closed, the vein closing it strikes the median nervure beyond its second divarication. Precostal nervure of hind wings originating

beyond the parting of the costal and subcostal; cell open or very feebly closed. No androconia. Tibiae and tarsi destitute of spines above, but with a single row of spines on the upper portion of the inner surface; two rows of spines on the under surface of the terminal tarsal joint, the outer rows being absent. Fore tarsi of female composed of five joints, all armed apically with similar spurs; apical joint in male armed with a single terminal hook or spine.

Abdomen: appendages of male much simpler than in the other tribes; upper organ small, simple, with a small central hook, sometimes notched. Clasps very large, simple, ovate, bearing a slight appendage at the tip and without the interior finger.

Egg. Compact, subglobular, of nearly equal height and breadth, furnished with many vertical ribs of no great elevation and equal throughout.

Caterpillar at birth. Head uniform, of about the width of the body; the latter covered with ranged, equal and minute papillae, bearing simple hairs, not longer than the width of the body, or even the length of the segments.

Mature caterpillar. Head much larger than succeeding segment, armed above with two or more stout generally very conspicuous thorns. Body cylindrical or sublimaciform, tapering toward either extremity, sometimes much larger and even abrupt at the anterior end of the abdominal area, the terminal segment generally ending in a pair of tapering points, as in Satyrinae; surface covered only with minute granulations arranged with more or less regularity, bearing exceedingly short hairs. Abdominal segments divided by transverse creases into generally four, sometimes five sections, of which the anterior is the largest, the others subequal.

Chrysalis. Head projecting beyond and distinct from the thorax. Base of the wings with only a single rounded tubercle; dorsum of mesothorax regularly rounded and uniformly carinate; dorsum of abdomen sometimes strongly carinate, sometimes not, but without conspicuous longitudinal carinae or tubercles on separate segments, but sometimes with a transverse carina on fourth segment; cremaster conspicuous, of very variable form.

This is a somewhat anomalous or aberrant tribe of the Nymphalinae, showing, at least in its early stages, many marked affinities to the Satyrinae. The egg for instance differs from those of all other Nymphalinae with vertical ribs, in that these ribs are not more elevated in the upper than in the lower half; the caterpillar at birth is clothed like the Euploeinae with comparatively short hairs, but all the papillae upon the surface are of similar character and size; the mature caterpillar strikingly resembles the Satyrinae in the clothing and general form of the body, and even generally though not universally in the bifurcation of the terminal segment, so characteristic of the Satyrinae. The chrysalis again is unlike that of the Nymphalidi, to which the imago is certainly more nearly allied, in that it possesses no conspicuous discontinuous prominences such as tubercles, and on the other hand sometimes has a mediodorsal carina like the *Libytheinae*, sometimes a transverse abdominal carina like the *Euploeinae* or some *Melitaeidi*.

The butterflies are mostly of a dark color, although dull yellow and tawny tints are often seen on the upper surface of the wings; the under side is almost always pale brown, enlivened by darker and brighter markings, which often take the form of ocellated spots; the wings are generally somewhat falcate, indicating a strong and vigorous flight; many of the species are particularly fond of elevated positions and as a rule are accus-

tomed to fly higher than most butterflies. Constant, writing of the European species of *Apatura* says (Cat. lép. Saone-et-Loire, 31) :—

They seldom leave the grand routes, and the avenues of lofty forests. Far from seeking flowers like other diurnals, they are particularly fond of the juices which exude from wounded trees, excrement of every kind and even putrifying carcasses of animals. One must hunt them in the morning, for it is only then that they lower themselves sufficiently in their flight to be taken by the net.

“They never meet,” says Haworth, “without a battle, flying upwards all the while and combating with each other as much as possible; after which they will frequently return to the identical sprigs from which they ascended.” The flight of *Potamis ilia* is described by Meyer Dür as resembling that of a bird of prey; it rises to the top of the highest trees, sweeps majestically in the air with occasional movements of the wings, allows itself to descend gradually, flaps its wings again as if spying out danger and then flies fitfully backward and forward until it alights on the very spot of moist earth which it had left a few minutes before, and where it will finally become a sure prey to its dangerous persecutor—the entomologist.

The butterflies are principally confined to the hotter regions of the globe, but a few penetrate to the temperate zone; both worlds nourish them, but there are only two or three genera in North America.

The egg of the European *Potamis iris* is described as resembling “a fossil *Echinus* which has lost its spines;” but that of our species of *Chlorippe* closely resembles those of some *Satyrinae*. The caterpillars at birth are remarkable for the brevity of the ranged hairs which cover them; when mature they are devoid of any prominences or heavy armature upon the body, being clothed only with short hairs, but the head is usually crowned with conspicuous tubercles; the body tapers considerably toward either extremity and causes the head to appear unusually large; they live singly when full grown (although the eggs are sometimes laid in masses and they are then gregarious in early life) and often weave from the leaf of the tree on which they feed a little nest, in which, when not feeding, they remain concealed. They are very sluggish and when in motion keep the head in constant movement to one side and the other. Newman (Illustr. nat. hist. Brit. Butt., 73) gives the following account of the habits of the European *P. iris* :—

A portion of the leaf is consumed every day, but the mid-rib is left intact; and the little creature, when resting from its alimentary labours, climbs to the denuded bristle-like tip of this mid-rib, and there remains perfectly motionless, with the anterior extremity raised. . . . The 15th of November it descended from the leaf, and, covering with silk the rind of the twig immediately below the attachment of the leaf, grasped this web firmly with its claspers, stretched itself out at full length, with its horns porrected before it, and thus settled itself down to endure the winter's cold and the winter's storms. This is always the case; its *modus operandi* is the same whether in a state of nature or in the vivarium of an entomologist. Instinct, that infallible and inscrutable guide, tells the unreasoning caterpillar that dehiscence of the leaf stalk will take place

after the first frost and that the leaf will fall to the ground: the leaf does fall, but not until its falling is a matter of indifference to the caterpillar; not until the caterpillar has attached itself so firmly to the twig that neither wind nor rain can remove it.

A South American species is described by Müller with similar eating habits, which also resemble those of our native *Anaea*, but the species of *Chlorippe*, as will be seen, act very differently. The chrysalids have a general resemblance to those of the *Satyrinae*. The insects appear to be commonly single brooded and to pass the winter, either, as stated above, in the caterpillar state or as butterflies.

Some of the most showy of butterflies belong to this group, their upper surface resplendent with glossy purple and blue reflections, most strikingly exhibited by the males. Our own species have warm tints but are not exceptionally showy. Among the south Asiatic species there is one which appears to mimic another Nymphalideous genus, *Athyma*, belonging to the Nymphalidi, a supposition which is strengthened by finding the same *Athyma* also mimicked by other genera and therefore presumably "protected." The mimicry can be of service to it, however, only when the wings are expanded, as in sailing, as the mimicry is confined to the upper side. Its position at rest is unknown, but if it should prove to rest with wide open wings while its congeners do not, the case would be vastly strengthened.

Only one genus of the tribe occurs in eastern North America.

CHLORIPPE BOISDUVAL.

Chlorippe Boisd., Doubl., List. Lep. Brit. mus., 108 (1844).

Apatura (pars) Auctorum.
(Not *Doxocopa* Hübn.)

Doxocopa Herr.-Schaeff., Prodr. syst. lep., i: 80 (1865).

Type.—*Pap. agathina* Cramer.

Lovely, light as cloud in sky,
Butterfly,
Over flowers thou flittest free,
Dew and blossom food for thee,
Thyself a blossom, flying leaf;
Who purpled thee by rosy fingers'
Touch so brief?

Was it a sylph, that thy sweet dress
Did so impress?
Of morning odors moulded fine
Thy beauty for one day to shine;
O little soul, and thy small heart
Beats quickly 'neath my fingers there,
And feels death's smart.

Fly hence, O little soul, and be
Bright and free;
An image of that later birth,
When man, the chrysalis of earth,
Like thee, a zephyr shall become,
And kiss in odor, dew, and honey,
Every bloom.

J. V. H. — *After Herder.*

Imago. Head (52:10) large, pretty uniformly and densely clothed with not very long hairs. Front pretty uniformly tumid, slightly fuller beneath, all the sides pretty abrupt,

as broad as high, a little narrower than the eyes; upper edge hollowed in front of the antennae, the middle protuberance thus formed well rounded; lower edge broadly rounded. Vertex transverse, tumid, well rounded behind, hollowed in front behind the antennae, extending forward between them and angulated; connected with the front by a very narrow and very deep channel between the antennae, the sides of which are very high and diverge, partially surrounding the antennae. Eyes pretty large, full, naked. Antennae inserted in the middle of the summit, in very deep, nearly connected pits, their interior bases scarcely separated, their exterior close upon the margin of the eyes; nearly twice as long as the abdomen, composed of forty-six joints, the terminal fourteen of which expand very gradually into a cylindrical club, constantly augmenting in size, a little flattened beneath and furnished with an indistinct carina; the last four or five joints, where the club diminishes in size, have a peculiar construction, being much broader on the interior than on the exterior side, thus causing them to face more and more outward, without much affecting the shape of the antenna itself, the tip of which is bluntly rounded, a little angulated at the outer terminal angle, where the tip lies; the club is from three to four times broader than the stalk and fully four times as long as broad. Palpi moderately stout, scarcely half as long again as the eye, the terminal joint very small, scarcely more than an eighth the length of the middle joint, the lower portion of the basal joint and the outer half of the upper surface of the middle joint furnished with pretty long projecting hairs and scales.

Prothoracic lobes large, tumid, well rounded, diminishing a little exteriorly, about three times broader than long and apparently longer than high. Patagia very little convex, broad and well rounded at the base, tapering rapidly in the basal half, beyond nearly equal, curving slightly downward, the tip sharply rounded, the whole fully three times as long as broad.

Fore wings (38:11) nearly twice as long as broad, the costal margin slightly and pretty regularly convex, a little more curved near the apex, the outer angle rather abrupt, the outer margin strongly sinuous, particularly in the male, the upper third — above the middle of lower subcostal interspace—considerably produced, its margin nearly straight and at right angles with the apical portion of the costal margin; behind this, receding with a well rounded curve, the lower third being slightly convex, the lower outer angle well rounded; inner margin straight. First superior subcostal nervule arising at a short distance before the extremity of the upper border of the cell; the second originating at an equal distance beyond the same; the third starting at a little less than half way from the second to the fourth; the fourth at about two-thirds the distance from the origin of the first to the outer margin; cell open.

Hind wings with the costal margin strongly expanded at the base and roundly bent at a short distance from it, beyond which it is scarcely convex, the outer angle well rounded; outer margin more or less sinuous, the whole subcostal region and the lower fourth of the margin being roundly and broadly prominent, — in our species considerably so, the latter projection almost forming a broad tail (♂), or considerably and pretty regularly rounded, slightly fuller from the middle subcostal to the middle median nervule (♀), in both a little crenulate; inner margin strongly expanded at the base, beyond slightly convex, the apical fourth a little and roundly emarginate, the outer angle rounded off. Precostal vein arising a very little beyond the divarication of the subcostal from the costal, curved strongly outward; cell closed.

Fore legs small, cylindrical, in the male clothed, especially on the inner side, with some long hairs which do not project greatly from the leg, the tibiae less than half the length of the hind tibiae; tarsi either fully as long as the tibia, composed of but one tapering joint, armed at tip with a minute apical thorn (♂); or but little more than half as long as the tibia, distinctly divided, as seen without denudation, into five joints of nearly equal diameter, the basal joint nearly twice as long as all the rest together the others nearly equal, all furnished beneath with a pair of small, short, rather slender apical spines (♀). Middle and hind tibiae of equal length, furnished on either side beneath with a row of short and slender, scarcely diverging, not very frequent spines,

the apical pair prolonged into slender but not very long spurs. Tarsi having the basal joint nearly as long as all the rest together, the three following decreasing regularly in length, the fifth as long as the second; the tarsi are provided beneath with four (the terminal joint with only two) rows of short and slender small spines, the apical ones of each joint a little longer than the others. Claws of moderate size, compressed, rather slender, strongly curved, finely pointed. Paronychiae very slender, delicate, tapering, slightly curved, nearly as long as the claws. Pulvillus small, transverse, very narrow, with a small rounded projection in front.

Male appendages of the abdomen: upper organ with the body pretty broadly rounded laterally, scarcely arched longitudinally; hook depressed, more than half as long as the body and nearly half as broad, separated from it by a broad sulcation, constricted a little at the base and notched at the tip. Claspers gently and regularly tumid, formed of a thin vertical plate, directed upward as well as backward, about two and one-half times as long as broad, oval or broadly fusiform, the lower border rounded, the upper angulated, armed at the tip with a little hook.

Egg. Subglobular, of nearly equal height and breadth, the base rounded, except in the flattened middle half, the summit very broadly and regularly convex; sides from base to micropyle rosette with nearly equal, not greatly elevated, nor strongly compressed vertical ribs, 18-20 in number, connected by numerous very faint and delicate cross lines. Micropyle rosette rather large, composed of numerous subequal, rather regularly pentagonal or hexagonal cells, whose diameter toward the outside is about the height of the quadrate cells beyond, but diminishes in approaching the centre.

Caterpillar at birth. Head smooth and rounded, without tubercles. Body with regularly distributed papillae, each giving rise to a simple delicate hair not longer than the segments, the papillae arranged (so far as can be judged from Edwards's figures) in the following manner: a subdorsal series anteriorly placed; a supralateral placed just behind the middle; an infralateral anteriorly placed,—all these with one to a segment in each row; and a stigmatal series with two to a segment.

Mature caterpillar. Head subquadrate, strongly appressed, slightly deeper below than above, the summit crowned by a pair of strongly divergent, otherwise erect, strong, coronal spines, no longer than the height of the head, furnished with many stout and elongated radiating spinules, and the posterior flank of the cheeks with a frill of simple, elongated, curving spines. Frontal triangle hardly twice as high as basal breadth, scarcely reaching half way to summit. Ocelli six in number, five arranged in a very shallow curve, the first four equidistant and approximate, the fourth midway between the first and fifth, the sixth posterior to the fourth, superior to the fifth and equidistant from both, the connecting lines forming a right angle. Body segments obscurely divided into four subsegments by slight plications, the anterior being the longest, the second next, the third and fourth equal, and together slightly longer than the first, all abundantly and subequally supplied with very irregularly distributed, larger and smaller, minute, subconical or spherical papillae, slightly more numerous along slender supralateral and infrastigmatal lines, the larger papillae nearly half as large as the spiracles, and each furnished with a simple delicate hair as long as itself.

Chrysalis. Strongly compressed, being twice as high as broad, dorsally carinate, with strongly arched abdomen, and a distinctly arched, but not greatly elevated mesonotum; anteriorly the dorsal carina terminates with the thorax, and is supplemented by a pair of subdorsal carinae (as long as the space between their tips) which run from the tip of the slender, trigonal, pointed, ocellar tubercles toward, but not to, the middle of the mesonotum. The inner edge of the wing-cases is also carinate, and the lower surface of the body flat, as if appressed to a flat surface in hanging, the wings not being at all protuberant, and the surface, from below the basal wing tubercle to the cremaster, forming a single straight line. Cremaster very remarkable, forming a flattened disk on this same line, extending beyond the tip of the last segment proper as a depressed, triangular, pointed protuberance, with strongly margined sides, its inferior surface marked by two very long, parallel and approximate, but anteriorly divergent ridges,

studded with hooks, by means of which the chrysalis attached to the under surface of any object may lie with its ventral surface parallel to the plane of support, although unfurnished with a median girth.

This genus appears to be confined to the southern United States, Mexico, the West Indies and perhaps the western coast of South America, —each having its peculiar species. In Europe it is replaced by the allied genus *Potamis*, but on the Pacific slope of North America, at least within the limits of the United States, even the tribe appears to be wholly wanting. In the eastern United States the genus is represented by several species, two of which seem to occur side by side in nearly all localities, but only one of which has been found so near New England as to be properly admitted to this part of our work. The butterflies are of medium size, their fore wings somewhat produced at the apex, the outer margin sinuate; the outer margin of the hind wings is also sinuate in the male but rounded in the female. They are more or less dark tawny colored above, varied with fuscous and pinkish brown below and furnished on the hind wings with a submarginal series of rather small, sometimes ocellate rounded spots; sometimes a large spot is similarly situated on the lower half of the fore wing, previous to which is a sinuate series of pale markings crossing the middle of the outer half of the wing.

The species are single or double brooded, sometimes dimorphic but not seasonally dimorphic, and the winter is passed in the larval state after the second or third moult. The caterpillars are more or less gregarious in early life, but afterward live separately on the upper surface of leaves in slight concealment, made by causing the sides of a leaf or bunch of leaves to curl so as to leave them exposed only above. Swarms of one of our species appeared in the southern states in 1887.

The eggs are subglobular but flattened at base and depressed at summit, with numerous, rather coarse but straight, vertical ribs, and are laid in larger or smaller clusters, varying with the species.

The caterpillars at birth have a regularly rounded head without coronal tubercles, and a body of about the same width with longitudinal series of minute papillae, one to a segment in each of the three rows on either side above the spiracles, each emitting a short hair.

The mature caterpillars have a bristling head much larger than the segment behind it, with large and stout coronal tubercles, having coarse long spinules and a frill of curving, coarse and long spines; their body tapers either way from the middle, and is shagreened and striped longitudinally and obliquely. They feed on *Ardisia*, *Celtis*, *Cascaria*, etc.

The chrysalids are strongly compressed and dorsally carinate, with a very high abdomen and lesser but distinct mesonotal arch, the ocellar tubercles not very long, trigonal, slender and pointed, the ventral surface straight and the cremaster of excessive length, its ventral ridges armed

throughout with hooks, which, with the rigidity of the abdomen, allow it to hang in an oblique position.

Although closely allied to the European *Potamis* (*Apatura* Auct.), *Chlorippe* is clearly distinct in every point of comparable structure. The imago has slenderer antennae with a shorter and more abrupt club, slenderer and briefer palpi, and there are many other differences in the legs and the form and neuration of the wings. The mature caterpillar is remarkable for its frill of spines at the back of the head, the far briefer but much more bristling coronal tubercle and the stouter frontal triangle, as well as in the division of the body segments into four and not five subsegments, the coarser papillae and their occasional definite arrangement. The chrysalids also differ in their prominent mesonotum, straighter ventral surface and the shorter ocellar tubercles.

Only one species is found in or near New England, Mr. Edwards afterwards correcting his statement that *C. celtis* occurred there. The food-plant of both, the hackberry, is, however, found on the banks of the Connecticut at least as far north as Springfield, though rarely.

*EXCURSUS VII.—THE ANCESTRY OF BUTTERFLIES;
THE PRIMAÆVAL FORM.*

. . . all you restless things,
That dance and tourney in the fields of air :
You, Psyche's postman, trim and debonair,
With eye-like freckles on your bronzed wings;

Your secret's out! I know you for the souls
Of all light loves that ever caused heartache,
Still dancing suit as some new beauty toles!
Nor can you e'er your flitting ways forsake,
Till the just winds strip off your painted stoles,
And sere leaves follow in your downward wake.

EDITH M. THOMAS.

In the history of human life nothing is more apparent than that individuals are born and perish, while families survive; families die out, while nations continue to exist; nations also have their limits, and mankind outlives them.

It is the same in the past history of life in general, revealed to us in the stony book of nature. Species come and go, while genera still maintain their ground; and, in their various times, genera, families, and orders of animals appear and disappear, while the groups higher than they outlive them. From this it follows that the existing members of any group are but the merest fragment of its true whole; and yet it is in large measure from this fragment that we must deduce the true character and relations of the group, as well as its past history. Nowhere is this

more conspicuous than in the butterflies. There are probably at least ten thousand species now living; countless myriads must have enlivened the face of nature in past ages; yet less than twenty have been found in a fossil state; and these fossil remains are so recent in geologic time, and so similar in structure to existing forms, that we only seem to be carrying the present state of things a stage or two farther back, and becoming no wiser than before concerning the ancestry of the group. We need only say that the Lepidoptera as a whole go back to the Jura, but that no butterfly has been found before the tertiaries. It is not, however, with the ancestry of the Lepidoptera as a whole that we are concerned, but only with the highest members of the order, the families of butterflies.

Since, then, paleontology refuses her aid, we must look within the limits of the group itself for indications of its past history. In the New Zoology, classification and ancestry go hand in hand; indeed it is only as present structure gives us a clue to past history that it possesses much interest; and habit and modes of life have such close connection with structure that they bear willing testimony where formerly they were debarred a hearing. Our classifications are only expressions of confessedly imperfect attempts to represent the natural affinities of animals, and natural affinity is but another term for blood relationship, more or less remote. It is therefore impossible, in these days, to consider classification without assuming as a postulate that it is a present expression of a past history; and in that light no single feature is wanting in interest. In fact, nothing in nature is without its meaning, its connection with the past; and though in itself alone we may despise a senseless stupid fact, yet when it is placed beside others, with which it has harmonious relations, it becomes fruitful in meaning.

Drawing then upon our knowledge of the special structure of butterflies as it is developed in this work, let us first attempt to draw a picture of the primeval butterfly when it has so far advanced in structure toward the tribes at present existing as to be fairly butterfly and not moth. This original form must have possessed not only most of the features of the lowest family, but also, in a nascent condition as it were, all or nearly all the characters now common to the group, or which exist under some modified form in this or that offshoot, such special peculiarities being subsequent, more individualized developments of the ancestral type. With this clue, a careful study of the structure of each stage will give a result not far removed from the following.

The egg was globular, with flattened base, its surface nearly smooth, but covered with faint reticulations, growing more minute next the micropyle, which formed a series of a few kite-shaped cells arranged symmetrically around a common centre.

The caterpillar had a large, smooth, rounded head, a body composed of

thirteen segments, nearly uniform in size, the first of them bearing a chitinous dorsal shield, the first three a pair of horny legs, the sixth to the ninth and the last segments a pair of fleshy legs, spiracles upon all the segments except the last two, but those of the second and third in a very rudimentary condition, so as to be physiologically useless. The surface of the body was covered profusely with little papillae, from each of which sprung a minute simple hair. The new-born caterpillar, however, differed perhaps in this respect from the full-grown, in that its body was furnished with short club-shaped hairs arranged in dorsal, laterodorsal, and substigmatal series, their being two appendages to a segment in the lower series, and one to a segment in the others. In short, a form of hypermetamorphosis was already established in a simple condition.

Soo, too, metamorphosis was complete, and the chrysalis a perfect mummy with ensheathed limbs, its contours smooth, the head rounded, the ventral outline of the abdomen as curved as the dorsal, and the tail somewhat pointed; it was protected by a slight cocoon, and also secured within, in a definite position, by attachment at the tail and a girt around the middle.

The butterfly was heavy-bodied and covered with scales and hairs. The head was broad, the antennae did not encroach upon the eyes and were moderately long and clubbed just before the tip; the club was about three times longer than broad, curved at the base, and tapering but not hooked at the tip; the tongue was about as long as the body, with simple inconspicuous papillae near the tip; the labial palpi were bushy and rather long, the apical joint smaller than the others, and directed forward.

The front wings were somewhat triangular, twice as long as broad, with rather a pointed apex; and the hind wings rounded triangular, of about equal length and breadth. In the neuration of the former the costal and subcostal veins, with the upper branches of the latter, were closely crowded toward the front edge, at the middle of which the costal vein terminated; the subcostal vein ran to the outer border just below the apex of the wing and had four upper branches and one lower branch, none of them forked, the last upper branch striking the front edge just before the tip of the wing; the median had four equidistant branches, the last branch uniting by a cross vein a little beyond the middle of the wing with the lowest subcostal branch; the submedian ran to the inner angle and the internal was soon lost in the membrane. In the neuration of the hind wing the subcostal and median veins with their branches occupied the middle and larger part of the wing; each divided into three branches, all, excepting perhaps the first branch of the subcostal vein, originating beyond the middle of the open cell; the costal and subcostal veins were connate at the base, suddenly diverging when they parted, the former just reaching the costal margin, but not extending beyond it; the submedian and internal were simple and of nearly equal length.

All the legs were perfectly developed, the tibiae and tarsi spined below, the latter also furnished with a pair of longer spines at the tip and middle of all the legs; the tarsi were longer than the tibia, the first joint as long as all the others, and the last supplied at tip with claws and pad and special hairs.

In coloring and pattern they might have been divided into three general types: first, those whose wings were uniformly dark brown, darker above than below; second, those of similar appearance, but more or less enlivened in the middle with tawny above and yellow below, and having, besides, minute spots bare of scales near the centre of the wings, especially of the front pair; third, checkered species, black and white above, but below pale and sometimes washed with dashes of brown and yellow. When at rest, the wings were fully or almost fully expanded, and the places on which they chose to alight were the upper surface of leaves or the ground. Finally, the primeval butterfly was single-brooded and wintered in the chrysalis state.

Let us next consider what modifications of this assumed ancestral type exist at the present day, and what the relations of one tribe to another tell of their relative age and importance.

The family groups into which butterflies should be divided have been variously given all the way from two to sixteen. As the structure of the different stages becomes better known there is an increasing proof of the intimate connection of many of the groups formerly believed very distinct; and it is generally conceded by the better class of recent writers that there are only about half a dozen principal groups. My own study of their structure and transformations leads me to divide them primarily into only our families, namely:—

The Brush-footed butterflies, or Nymphalidae.

The Gossamer-winged butterflies, or Lycaenidae.

The Typical butterflies, or Papilionidae.

The Skippers, or Hesperidae.

The family nature of the last group has never been questioned by any who look upon the butterflies as composed of more than one family; indeed its distinction from the others is so marked that some have considered the remainder of the butterflies its equivalent in value; that is, they divide all butterflies into only two families. Probably these skippers were the first to separate from the common stock, and they certainly have never developed to a high degree, since they still remain by far the lowest of all, and are in many points more closely allied to some of the higher moths than to any other butterflies. They are peculiar for their robust body, broad head, such as we have given our archaic butterfly, hooked antennae, which are widely separated at base, large eyes, the cornea of which occupies the entire ocellar globe, and is overhung by a brush of curving unequal

hairs, great length of tongue, and the presence of a middle pair of spurs on the front and usually on the hind legs, in the former developed as a curious foliate membrane; their eggs are broadly truncate spheres, sometimes ribbed; their caterpillars have a large head with a very thick skull and a very contracted neck, formed of the first body segment and bearing a corneous shield above; their chrysalids are smooth and uniform, like the pupae of most moths, but in rare instances are pointed in front. In nearly all these features they resemble the picture we drew of the primeval type; but in the hooked antennae, foliate appendage of the fore tibiae and sexual diversity of the butterfly, the frequently ribbed eggs, the constriction of the neck of the caterpillar, and in the occasional projection of the head of the chrysalis, and possibly in the shrouds by which it is supported, they have departed from that type, and most of these peculiarities they share with no other butterflies. The other families appear to have diverged simultaneously from each other shortly after their common separation from the skippers; for they contain many characters in common which distinguish them from the skippers, such as the position of the tongue, which is inserted so low down as to give the head a vertical rather than, as in the skippers, a horizontal cast; the antennae are inserted near together; the tip of the club is never produced to a distinct point; the eyes have no distinct overhanging pencil of erect bristles; and the hinder portion of the ocellar globe is covered with scales, limiting the field of vision. All these, characters probably gained by the higher butterfly stock after its separation from the skippers, are points of minor importance and indicate but a brief period of common existence. Similarly it would appear as if the present families of *Lycaenidae* and *Papilionidae* remained together after their common separation from the *Nymphalidae*, for they contain several important characters in common, particularly the usually small head of the larva and its relation to the first thoracic segment (least noticeable but not lost in the *Pierinae*), together with the peculiar mode of suspension of the chrysalids. But all three of the higher families must soon have become differentiated and shown each in its own way the characters which are peculiar to it. Thus in the imago of the *Papilionidae*, the metathorax is markedly separated from the mesothorax, the front of the head between the eyes is as broad as high, the eyes themselves are prominent and are not infringed upon by the antennal sockets; while the more special characteristics of the two great groups into which this family is divided show that it became disintegrated at an early time, though it still retains very striking marks of its close affinity to the lowest types. The diminutive size of the *Lycaenidae*, the narrowness of the front of the head, the flatness of the eyes, the encroachment of the antennae upon their upper margin, and the consolidation of the metathorax with the mesothorax, together with the tiarate character of the egg, the more or less onisciform structure of the caterpillar, and the rounded, short and compact form of the

chrysalis, are characters which this group shares with no others. Here, too, we find the curious phenomenon of partial atrophy in the front legs of the males, though as a general rule not sufficient to interfere with their use. When, however, we come to the highest family, the Nymphalidae, this atrophy has gone so far as, with rare exceptions, to affect both sexes and to render the feet absolutely useless for locomotion; while the pendulous character of the chrysalis, the frequently spinous armature of the caterpillar, the almost universally ribbed surface of the egg, the complete separation of the antennal scrobes from the inner edges of the eye and the tumid prothoracic lobes of the imago, are characters which are, with some rare exceptions, confined to this group.

By means of a diagram, I once attempted to exhibit the apparent relation of these different families and their subdivisions to each other, their position on the genealogical tree being supposed to indicate, on the basis of existing affinities, the relative time at which the different groups diverged from each other or from the main stem; and the height which each branch attained marked the relative perfection of the highest members of that group. But it is impossible to represent this with any accuracy on a flat surface; for one may properly conceive of a group only as a mass, with branches springing from a common central core, and the sketch necessarily involved some errors. Thus the swallow-tails and lycaenids were brought at opposite extremities of the tree, whereas they are closely related to each other, and disagree with all other groups in the relation of the head of the caterpillar to the segment behind it; this relationship, however, was to a slight extent indicated by each occupying the lowest twig of the branch on which it was seated, both branches being closely connected at their base. The striking and unique peculiarities of certain groups were shown by their extreme divergence from the main stem; thus the swallow-tails stood apart from all others in the possession of dorsal osmaterias in the caterpillar; the lycaenids at the opposite extreme, in the onisciform nature and diminutive heads of their caterpillars; the castnioides among the skippers by their close approach to the moths, and the satyrs or meadow browns by the forked tail of their caterpillars. The superficial affinity of this last group to the skippers was also indicated by the directness of their line from the very base; it is one of the most curious features in the structure of butterflies that some of its highest and lowest members should resemble each other in so many minor points. For instance, the tone of coloring and pattern of markings on the wings of many satyrs, as well as the position and general nature of the sexual marks on the front pair of some males, find a close counterpart on the wings of some skippers; so also the chrysalids of satyrs are among the simplest, most rounded, and compact in the whole family, approaching in this respect the lowest butterflies. Nevertheless, in all the prime features of their organization, the satyrs outrank nearly all others.

CHLORIPPE CLYTON.—The tawny emperor.

Apatura clyton Boisd., LeC., Lép. Amér. sept., 208, pl. 56, figs. 1-4 (1883);—Morr., Syn. Lep. N. Amer., 68 (1862);—Edw., Butt. N. A., ii, Apat. 2: [1-13], pl. Apat. 2 (1876);—French, Rep. ins. Ill., vii: 155 (1878); Butt. east. U. S., 218-221, figs. 65-66 (1886);—Middl., Rep. ins. Ill., x: 89, fig. 15 (1881).

Doxocopa idyia (pars) Herr.-Schaeff., Prodr. lep., 80 (1864);—(pars) Gundl., Contr. ent. cub., 62-64 (1881).

Apatura lycaon (pars) Butl., Cat. Fabr. Lep., 57 (1869).

Doxocopa herse Scudd., Syst. rev. Amer. butt., 9 (1872).

Apatura herse Riley, Trans. St. Louis acad. sc., iii: 198, figs. 5-6 (1873); Rep. ins. Mo., vi: 140-150, figs. 41-42 (1874).

Chlorippe herse Scudd., Bull. Buff. soc. nat. sc., ii: 248 (1875); Butt., 262, figs. 182-183 (1881).

Figured by Glover, Ill. N. A. Lep., pl. 36, fig. 8, pl. A, fig. 18, ined.

CHLORIPPE CLYTON CLYTON.

Chlorippe herse (var.) *clyton* Scudd., Bull. Buff. soc. nat. sc., ii: 248 (1875).

Apatura clyton var. *ocellata* Edw. Butt. N. A., ii, Apat. 2: [1-2] (1876).

Papilio ——— Abb., Draw. ins. Ga. Brit. mus., vi: 32, figs. 43-44.

CHLORIPPE CLYTON PROSERPINA.

Apatura proserpina Scudd., Trans. Chic. acad. sc., i: 332 (1870).

Chlorippe herse (var.) *proserpina* Scudd., Bull. Buff. soc. nat. sc., ii: 248 (1875).

Apatura clyton var. *proserpina* Edw., Butt. N. A., 2, Apat. 2: [2-3] (1876).

[Not *Doxocopa idyia* Hübn.; nor *Papilio lycaon* Fabr.; nor (probably) *Papilio herse* Fabr.].

Beneath the summer sky
From flower to flower let him fly;
'Tis all that he wishes to do.

WORDSWORTH.—*Redbreast and Butterfly*.

Imago (16:7,9). Head covered above rather densely with rather short, equal, delicate, pale rufo-brownish hairs, more rufous behind than in front of the antennae; eyes broadly bordered posteriorly with dirty white scales, tinged, especially above and away from the eyes, with brownish yellow. Palpi on the basal half and lower portion of apical half, white; the erect hairs of the upper surface, except near apex of palpi, pale; sides of apical three-fifths of middle joint pale luteo-fulvous; apical joint throughout a little darker, darkest above. Antennae dark brownish fulvous above, fuliginous toward the base of each joint, beneath luteo-fulvous, the apex of each joint on the upper outer surface with a white spot; basal two-thirds of club black above, covered with brownish fulvous scales; beneath like the lower surface of the stem; apical third of club (the last six to eight joints) very pale clear yellow, immaculate; tongue luteous.

Prothoracic lobes covered with pale mouse brown hairs, considerably tipped with rufo-brownish; thorax covered above with rufo-fulvous and olivaceous hairs, beneath with shorter, dirty white ones; fore legs covered with long white hairs, excepting on the upper surface of tibiae and tarsi, where they are luteo-fulvous; other tibiae and tarsi, and to some extent the anterior portion of the femora, dull, pale brownish fulvous; spurs rufo-luteous tipped with pale rufous; spines rufo-luteous; claws rufo-luteous at base, dark rufous at tip; paronychial pale; pulvillus pale fulvous.

Wings above dark, more or less obscure tawny, marked with blackish brown. *Fore wings* with two transverse sinuous series of more or less rounded pale spots on the outer half of the wing; the inner series consists of a rather regularly sinuous series of six medium sized, subequal, subtriangular spots, their apices outward, the lower double; the upper three are in the two lower subcostal and the subcosto-median interspaces in a slight curve opening inward, at right angles to the costal margin and midway between the first divarication of the median and the apex of the wing; the next two are nearer the base of the wing, in the median interspaces, the lower a little within the upper; the lowest is in the medio-submedian interspace, in the middle of the outer three-fifths of the interspace, its inner border on a line with the outer border of the spot above; the outer series consists of five smaller, quadrate spots, occupying the same interspaces excepting the medio-submedian; the upper one is a little less, the one next below a little more, than half way from the spots of the inner row to the outer border; the

lower three are in a slightly curving row subparallel to the outer border, the lower midway between the spot of the inner row and the outer border; the spots of both of these rows are normally dull whitish, but are always more or less, and generally considerably, obscured by fulvous or reddish scales, so as often to be inconspicuous. The outer limit of the discoidal cell is marked by a rather broad, bent, blackish bar and a similar, but straight, though irregular bar crosses the cell just above the first divarication of the median; following the inner edge of the inner row of pale spots is a continuous or nearly continuous, rather narrow stripe of blackish brown; beyond the inner row of pale spots, and sometimes between them and the apex of the cell above the median nervure, the wing is more or less obscured with blackish or brownish fuscous, deepening in spots of greater or less extent, especially on either side of the pale spots, approaching black in the subcostal interspaces; where lightest—and some specimens show little more than a slight infuscation—enlivened by orange tawny scales; the outer border is margined with blackish fuscous to the depth of less than half an interspace, and followed by a lighter stripe, broadening and brightening as it passes downward, near the inner border as broad as the border, and nearly as bright as the base of the wing. Fringe dark fuscous, interrupted rather narrowly and inconspicuously in the middle of the interspaces with white. *Hind wings* rather more uniformly and extensively tawny than the fore wings; the basal two-thirds are more or less streaked with faint fuscous, a little more intense at its distal limit; in the middle of the outer half of the wing is a series of seven roundish or oval, purplish black, pretty large spots, subparallel to the outer border in all the interspaces from the costal to the submedian nervure; the first (counting from above), second and fourth are in a single row, and so are the second, fifth and sixth, and the third, sixth and seventh; the first, third and fourth are round; the second longitudinally oval, and the lower three are obliquely oval, their major axes directed toward the middle of the costal margin; the first and seventh are small, the others subequal, the second usually a little the largest, the fifth in the middle of the upper median interspace and occupying about three-fifths its width; these spots are surrounded by a tawny nimbus of greater or less extent, sometimes so extended as to form a continuous band in the middle of which the spots are placed; the nervules are, however, usually dusky; the outer border to fully the depth of half an interspace is blackish fuscous, or occasionally tawny fuscous, its interior limit blackish fuscous, in which case it is surmounted by a continuous series of shallow, lunate, slightly pale spots, edged interiorly by a faint line of fuscous. In some instances the whole upper surface of the hind wings is deeply infuscated with blackish brown, tinged toward the base with tawny, but otherwise uniform, excepting a slight tawny edging to the sometimes inconspicuously darker extra-mesial row of spots, and slight broken spots of color, marking the limit of the otherwise indistinguishable outer border of black. Fringe as in the fore wings.

Under surface of *fore wings* very pale, dull dirty fulvous at base as far as the extra-mesial row of subtriangular spots, which are more distinct and slightly larger below than above, and bordered interiorly by an almost always continuous, slender, blackish fuscous stripe; the two bars in the cell are also repeated beneath, as well as the outer row of pale spots, which are sometimes white and that in the lower subcostal interspace sometimes encircled with brownish; the outer half of the wing is brownish, often, and especially in the median area, considerably tinged with ferruginous; there is a submarginal, slender, crenulate stripe, more distinct and broader below than above, of blackish fuscous, sometimes tinged with castaneous, corresponding to the inner limit of the marginal band of upper surface, and outside of which the edge of the wing is slightly tinged, like the outer half of the wing above the median, with dull nacreous; interiorly the submarginal stripe is followed by a series of usually disconnected crescents of the same color as the stripe, generally shallow and at less than an interspace's distance from the margin of the wing, but often, and especially in the next to the lower subcostal and subcosto-median interspaces, high and angulated,—in all cases enclosing between themselves and the submarginal stripe paler spaces, generally similar in color to the border of the wings; all the veins brownish; fringe much as above. *Hind wing* from base to a transverse mesial stripe very dull brownish nacreous, often

more or less grayish; the stripe is generally continuous, very slender, nearly equal, dark brownish fuscous, often tinged with reddish; it starts from the costal nervure and crosses the costo-subcostal interspace at right angles, as a crescent opening inwards, strikes the upper subcostal at a distance from its origin about equal to the width of the interspace just crossed, passes in a broadly curving line, opening inwards, to the upper median nervule at a short distance from its origin; it then passes still nearer the origin and crosses the two median interspaces in a straight line or in a similar curve, nearly or quite at right angles to the nervure it crosses; then it follows the lower median nervure for a considerable distance outward, or to as far again from its origin as it was when it struck it, passes to the middle of the submedio-internal interspace, opposite the previous transverse portion of the stripe, in a deep loop which crosses the submedian but little short of the middle of its outer two-thirds; from the middle of the interspace it is bent at right angles, strikes the internal and is then again directed toward the base of the wing; within this stripe there are two conspicuous blackish fuscous bars, one connecting the lower subcostal and upper median nervules along the track of the nervule which closes the cell (or would close the cell were it closed), the other transversely crossing at least the upper half and sometimes the whole of the cell, just within the first divarication of the subcostal; the mesial stripe is followed exteriorly by a nearly uniform band about an interspace in width, but with its outer limit generally shading gradually into the tint beyond, generally of a pale ashy hue, but sometimes more or less tinged with dull nacreous; the outer border is marked with a submarginal crenulate streak and presubmarginal crenate lines similar to those of the fore wings, but more regular and uniform and with all the colors of this portion of the wing similar to the fore wing; between these markings and the extra-mesial band is a field of a warm yellowish brown tint, often tinged more or less with feruginous, the middle of which is occupied by a transverse series of seven roundish spots, which, when fully developed, are well formed, nearly equal ocelli, occupying every interspace between the costal and sub-median, the lowermost double and yet smallest; they consist normally of a pale blue minute pupil set in black, in the middle of a spot of the color of the field in which the spots are situated, and encircled with yellowish green and then more narrowly with blackish brown; the whole seldom occupies more than two-thirds the width of an interspace, even when, as in the median interspaces, the spots are obliquely oval and in which case the pupil becomes linear; the blue scales are often obsolete; generally, however, these ocelli become almost entirely obscured by an intermingling of the scales and the partial confluence of the spots which then follows, in which case they seem to form only a deeper, more feruginous band within the darker area, with the spots usually partially limited, frequently with faint traces of the pupil, which is then oftenest pale or even whitish, and generally obliquely linear in all the interspaces; the veins are dusky and the fringe similar to that of the upper surface.

Abdomen above blackish, covered with brown and tawny scales; below pale griseous. Male abdominal appendages (33: 10, 10a): hook of upper organ, sharply constricted at the base, notched in the middle of the tip half way down to the constriction, the sides of the notch parallel to its bottom, narrowly separated, thus forming two lobes, very broadly rounded at the outer hinder angle, curved slightly downward, and, especially near the tip, inclined slightly toward the opposite lobe; clasps two and one-fourth times as long as broad, the free upper edge a little wavy, armed at the tip with a slender, tapering, finely pointed, regularly and considerably incurved hook, as long as the lobes of the hook of the upper organ.

Measurements in millimeters. Length of tongue, 10 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of wings.....	23.	25.5	28.	33.5		
antennae	13.	15.				
hind tibiae and tarsi..	7.	8.5	8.75	9.2		
fore tibiae and tarsi..	3.	4.	4.8	4.		

Described from 4 ♂ 1 ♀.

The above description is drawn up from specimens of *C. c. clyton* alone, the form *proserpina* not having yet been found on the confines of New England. It differs from the other form by an infuscation of the upper surface and particularly of the hind wings.

Egg (64: 6, 7). Pale yellowish white, with the sides almost straight in the middle half, rounding abruptly to the summit so as to be almost shouldered, the summit therefore very broad and only slightly convex. Vertical ribs about twenty in number, rather coarse and rounded, not greatly elevated, the cross lines straight and obscure, forming cells about four times as broad as long in the middle of the egg, the surface within rather coarsely but very shallowly punctate or subrugulose. Micropyle rosette about .15 mm. in diameter, the outer cells subequal with stout walls, growing rapidly smaller within, where they are all oval, those of the innermost row, about a dozen in number, with the longer axis about .015 mm. in length, slenderest at inner end, and all radiating from a central circular cell about .005 mm. in diameter; all the interior cells with far more delicate walls than the outer. Height of egg, .6 mm.; breadth, .54 mm.

Caterpillar. *First stage.* Head (87: 7a) piceous, the mouth parts dull castaneous. Body white, the last two segments with the superior projections fuscous; legs and prolegs white, the last joint of the former faintly fuscous; hairs pellucid; stigmata apparently concolorous with body. Length, 1.5 mm.

Second stage. Head (87: 7b) pale yellowish green, marked with brown specks, the ocelli and mandibles brown. Body pale green, with a slender, dorsal, dark green line, and three pairs of dark green longitudinal stripes, the middle, lateral stripe broadest and most conspicuous; hairs white; legs and prolegs pale green. Length 3.2 mm. (After Edwards and Riley.)

Third stage. Head (87: 7c) and its papillae pale livid green, flecked abundantly and very minutely with brown at the anterior base of the coronal tubercles, the middle of the summit, the ocellar field, the frontal triangle and the mouth parts. Body green with broad, subdorsal, white bands and equal, suprastigmatal and infrastigmatal, white stripes; each of the conical papillae, everywhere profusely scattered over the body, supports a pellucid or white hair twice its own length; anal protuberances whitish. Legs and prolegs concolorous with the body. Length, 7.6 mm.

Fourth stage. According to Riley this does not differ from the preceding except that the head (87: 7d) becomes greener, the papillae of the body more conspicuous and the medio-dorsal dark stripe proportionally narrower.

Last stage (74: 20). Head (87: 7e) very pale green, with two rather broad, curved, white stripes down the face, passing above to either side of the prominent tubercle; the latter pale lemon green, sometimes marked more or less with black in front; its spinules like the others of the head pale, whitish green; hairs of head white; ocelli and mandibles black; other mouth parts white.

Body striped in green, yellow and white in continuous and equal bands from head to tail. A median bluish green line; next it the whole dorsal surface white, tinged on the interior half with yellow; the division of the white and yellowish white marked by a very faint, fine, broken, greenish line, sometimes obsolete; an infralateral, rather broad, dark green band, flecked along the middle with confluent white dots; a suprastigmatal white band of nearly equal width tinged slightly with yellow; a similar, but light green, stigmatal band with a faint, white line running along the middle; and a substigmatal band wholly like the suprastigmatal; beneath very pale green; tubercles white with white hairs; stigmata and prolegs very pale green; caudal horns pale green, but white from the tubercles which completely cover them. Legs pale green tinged with yellow. Length of whole body, 37 mm.; width at first thoracic segment, 3.75 mm.; at third abdominal segment, 6.5 mm.; at last abdominal segment, 2.6 mm.; length of caudal horns, 2 mm.

Chrysalis (83: 15-17). Color above in general pale grass green; below, very pale pea green, the dividing line between the two being a narrow, yellow stripe following the posterior edge of the wing cases to the abdomen, where it forms a less distinct infra-

stigmatal stripe; a similar, narrow, yellow stripe marks the entire dorsal crest, becoming pale on the thorax and fading out in front of two pale whitish stripes, bordered interiorly with green, which follow the ridges from the ocellar tubercles toward the middle of the mesonotum; a similar, straight, oblique, pale stripe bordered interiorly with green crosses the second abdominal segment parallel to the posterior borders of the mesonotum, and similar but much fainter and more oblique stripes cross the abdominal segments behind this, midway between the infrastigmatal stripe and the dorsal crest; the dorsal surface of the abdomen and to a certain extent of the thorax is mottled irregularly and delicately with yellow; the lateral bases of the teeth marking the anterior limit of the dorsal crest on the 3d—8th abdominal segments are marked by a black dot; stigmata very pale yellow; cremastral hooks very pale horn-color. Length, 23.5 mm.; height at third abdominal segment, 10 mm.; at thorax, 7.5 mm.; breadth near tip of wings, 7.8 mm.; greatest breadth at base of wings, 7.8 mm.: at the ocellar tubercles 3. mm.; length of latter, 1.1 mm.; distance from their tips to dorsal spine of third abdominal segment, 14.5 mm.

Distribution (19: 1). This is one of the characteristic members of the Carolinian fauna, its proper home being in the southern United States east of the Great Plains; but it extends beyond its northern boundaries, reaching as far as Iowa (New Jefferson, Allen; Des Moines, Austin; Ames, Osborn) and even Wisconsin "rather rare" (Hoy) in the northwest, and in the northeast to southern New York (Brooklyn, Meyer; Newburgh, Edwards). It is found as far west as Kansas (Snow) and southern Texas (Aaron), and seems to be more abundant in the Mississippi Valley than east of the Alleghanies, Abbot calling it rare in Georgia, and Edwards having never seen the butterfly in flight in West Virginia, although he has found the larvae.

Its occasional occurrence in southeastern New York is its only claim to be looked on as a possible New England insect.

Oviposition. According to Riley and Edwards the eggs are laid on the under side of leaves in large, dense patches (64: 7) of from less than two hundred to five hundred, in two or oftener three, sometimes even four or five tiers.

Food plant. The only plant known upon which the larva lives is the hackberry, *Celtis*, a genus of the Urticaceae, feeding indiscriminately upon all the forms found where it occurs, but especially upon *C. occidentalis*. Boisduval and Leconte state that it feeds on many species of *Prunus* and on other trees of the same family (Rosaceae), but this is probably a complete error, as Edwards and myself have been unable to induce them to eat them. One, however, that I raised ate freely, in its third stage, of *Aristolochia*, a much more nearly allied but by no means closely related plant.

Habits of the caterpillar. The caterpillars, when ready to hatch, bite a narrow channel almost completely around the egg at the upper shoulder, and lifting up the lid thus formed, like a reversed saucer, escape without further devouring the egg. They are gregarious during the first

three stages, "feeding side by side, eating the leaf from the tip downward, but leaving the stouter ribs. Spinning a thread wherever they go, they often, in travelling from leaf to leaf, make quite a pathway of silk; and if the branch be suddenly jarred, they will drop and hang suspended in mid-air, and after reassurance climb up again with the thoracic legs" (Riley). In thus feeding together they completely conceal the leaf, according to Edwards, but do not, as in many gregarious larvae, "rest with heads all turned the same way and bodies in line and parallel . . . but form an irregular mass, the heads mostly outside and fronting in every direction." They often assume a very odd position, first noted by Edwards, in which there is a sinuous bend in the middle of the body, the front half being thrown by half its width to the right or left of the hinder end, but both straight and parallel; they even may have this position when fixed for change of skin. They also frequently rest with the head bent over so that the front lies flat upon the surface of rest, and thereby hunch a little the second thoracic segment; it is in this position, according to Mr. Edwards, that they hibernate. Mr. Edwards found his larvae feeding principally at night, but mine fed equally by night or day. He also states that they prefer the thickest leaves, and Mr. Riley adds that they select the lower branches. "From the earliest stage, the surface of the leaf about and beneath these larvae was kept thoroughly clean, but just outside the group was a mass of excrement in a pretty regular ridge," formed at a certain active cleansing period. "When a bit of frass was encountered by [some] . . . who seemed especially deputed to act as scavengers, it was seized by the mandibles . . . and by a snap the frass was thrown . . . at least two lengths of the caterpillar. If . . . it fell short, either one of the larvae on which it struck seized it or it was met by one of the scavengers, and was again snapped off, until . . . the obnoxious thing was gotten rid of. . . . This sanitary work could only have been necessary when the larvae were in confinement, as in nature they would have rested on the under side of the leaf" (Edwards).

After the third moult, the caterpillars scatter and live independently; some which I had crawled to separate terminal leaves of twigs where they took up their permanent abode, returning to the leaf after excursions up the stalk for food, resting always upon the upper surface. After a time, apparently by repeated zizzagings at every return, the sides of the leaf or leaf-cluster were brought toward each other to form a kind of trough, so that the caterpillar was in view only from above. One, when removing to new quarters, made at once of several leaves a sort of open bower which concealed it well, though not completely. The skin cast at each moult is devoured.

Life-history. Thanks to Messrs. Riley and Edwards the history of this butterfly is tolerably well known. The caterpillars winter when half

grown, marked generally by the third moult; they cluster upon the leaves and fall with them to the ground, and in spring make their way again from the ground to the tree; the caterpillars become full grown by the end of May and later in West Virginia, hang in chrysalis for about ten days, and appear on the wing in June, the males earliest; or, being delayed by slower growth, some may not appear before July; the eggs are laid early in July, hatch in eight or nine days and the larvae feed in company until the time for hibernation arrives, when, huddled together in companies of five or more on a leaf whose surface they have covered with silk and thereby curled somewhat, they change with the leaf to a brownish or vinous color and drop with it to the earth; or in Mr. Edwards's opinion, who thinks that such larvae perish, they may hide in the ample crevices of the rough bark of the hackberry. Mr. Edwards believes there is only one brood in West Virginia. Mr. Riley speaks of no difference between the seasons of this species and *C. celtis*, which feeds upon the same plant, is very frequently found upon the same tree, and is double brooded. That our species is double brooded also on the Atlantic coast is evident from the data given further south, in Georgia, by Abbot, who records butterflies taken by him May 1 and again September 5. I have also seen fresh Texan specimens taken September 9 and 10, so that it is certain that if single brooded in West Virginia and Missouri, it is double brooded near the Gulf.

Habits, flight, etc. The butterfly is found in the vicinity of swamps, according to Abbot, while Mr. Dury has taken it "sometimes on trees from which there was an exudation of sap, and sometimes on rotten apples; but in most cases it is to be seen in the woods" (Edwards). Its movements are said to be less lively than those of its companion *C. celtis*, which is described as exceedingly alert and restless, darting from one object to another so swiftly that the eye can scarcely follow it.

It is a dimorphic species, the dimorphism affecting both sexes and being so far as known independent of season; this was proved by Mr. Edwards, who raised, in West Virginia, from one set of wintering caterpillars, four males and four females of the form clyton, and eight males and five females of the form proserpina. All were raised from eggs found in the open air, presumably those found by him July 4-6. On account of this dimorphism, Mr. Edwards exposed some chrysalids to severe cold, but as the experiment was tried when they were less than six hours old it only resulted in death.

Enemies. Out of ten bunches of eggs found in Missouri by Mr. Riley, eight proved to be more or less infested with a minute Chalcid, *Telenomus rileyi*, one fly to each egg. "The egg thus infested becomes purplish, so as readily to be distinguished from the sound ones, and even when empty, an egg that has been parasitized is easily recognized by the crown being

perforated instead of lifted up." *Chalcis ovata* Say (88: 14-15) has also been bred in September from chrysalids found by Mr. Riley in South Carolina; and *Limneria fugitiva* by Mundt. The destruction of life during the winter from natural causes and marauding insectivorous creatures must be enormous. Miss Murtfeldt found a young *Celtis* on her lawn, where "in many cases the entire under surfaces of certain leaves would be covered with the tiny larvae, stretched side by side in rank after rank from tip to base," yet the following spring she was able to find on the tree but three or four nearly full grown caterpillars. "Considering the vast numbers that were on the tree the previous autumn, one is almost appalled at the waste of life permitted by Nature."

Desiderata. The most interesting and important questions concerning this species relate to its life history and its dimorphism. Its behavior at different latitudes needs investigation to show the relation between its history in the northern part of its range, where it is apparently single brooded, and in the southern, where, unless the butterfly hibernates (as is highly improbable), it is certainly double brooded. The difference of the behavior in different broods of caterpillars raised by Mr. Edwards may be accounted for when this is clearly understood. This knowledge becomes of greater importance in its relation to the dimorphism of the butterfly, which appears to be quite independent of season in the north; and if we have here only a single brood, it will be difficult to correlate this dimorphism with that (almost exactly parallel so far as the effect produced) which is found in the digoneutic species of *Polygonia*; so that here is an ample field for study, where experimentation also may have full scope; some southern lepidopterist in one of the larger cities, where ice is artificially produced, ought to apply himself to the problem. There are also other points which need elucidation; the northern limit of the range of the butterfly; its occurrence about New York; the length of time in which the butterfly remains in flight (throughout July in Iowa); the history of its egg parasite; a satisfactory reason for its rarity as compared to *C. celtis*; and the mode and place of hibernation of the caterpillar.

LIST OF ILLUSTRATIONS.—*CHLORIPPE CLYTON*.

Egg.

- Pl. 64, fig. 6. Colored.
7. A cluster of eggs on a leaf.

Caterpillar.

- Pl. 74, fig. 20. Full grown, colored.
87: 7, a-e. Front view of head in stages i-v.

Chrysalis.

- Pl. 83, fig. 15. Side view, colored.
16. Outline, side view.
17. Outline, dorsal view.

Imago.

- Pl. 16, 7. Male, upper surface, with outline of wings of female.
9. Male, under surface.
33: 10, 10 a. Male abdominal appendages.
38: 11. Neuration.
52: 10. Side view of head and appendages enlarged, with details of the structure of the legs.

General.

- Pl. 19, fig. 1. Distribution in North America.
88: 14-15. *Chalcis ovata*, a parasite.

TRIBE NYMPHALIDI.

WHITE ADMIRALS.

Nymphalidi (pars) Steph.; Nymphalidae Dup.;	Neptidae Newm.
Nymphalitae Luc.; Nymphalides Kirb.	Carunculatae (pars) Guen.
Archontes (restr.) Herbst, Scudd.	Papiliones maculato-fasciati Wien. Verz.
Limenitides Butl.; Limenitidae Burm.	

. . . Thou didst drink
The stale of horses, and the gilded puddle.
Which beasts would cough at.

SHAKESPEARE.—*Antony and Cleopatra*.

Winged wanderer from clover meadows sweet,
Where all day long beneath a smiling sky
You drained the wild-flowers' cups of honey dry
And heard the drowsy winds their loves repeat,
What idle zephyr whispering deceit
Has won your heart and tempted you to fly
Unto this noisy town and vainly pry
Into the secrets of this busy street?

To me your unexpected presence brings
A thought of fragrant pastures, buds and flowers,
And sleepy brooks, and cattle in the fold;
Or, watching as you soar on trembling wings,
I think for those who toil through weary hours
You are a type of their uncertain gold.

SHERMAN.—*A Butterfly in Wall Street*.

Imago. Head: club of antennae very long, so gradually increasing in size as to render the determination of its origin difficult, cylindrical or a little depressed, with four inferior carinations. Palpi slender, with compact, recumbent scales; terminal joint scarcely one-fifth the length of the middle joint.

Thorax: first and second superior subcostal nervules of fore wing arising before the tip of the cell; the third and fourth beyond; cell closed; median nervure connected opposite its last divarication with the vein closing the cell. Precostal nervure of hind wing originating opposite the divarication of the subcostal from the costal nervure; cell open. No androconia. Five joints to the fore-tarsi in female; apical joint of male terminating in a single median spine; the other joints with spurs in pairs, but no spines; other tibiae and tarsi destitute of spines above, but with the upper portion of the inner surface crowded with irregularly disposed spines; four rows of spines on the under surface of the terminal joint of tarsi.

Abdomen: male appendages; upper organ about as large as the lower, bearing a single pointed, curved hook. Clasps large, tapering considerably on the outer half, the upper process apical and spiny, the interior finger originating near the base of the inferior edge, directed upward and surpassing the superior edge of the clasp.

Egg. Globular, flattened at base and slightly depressed at apex, the whole surface covered with pretty large hexagonal cells, bounded by abrupt elevated walls, emitting at the angles prominent filaments.

Caterpillar at birth. Papillae of the body conspicuous, some larger than others, the hairs short, slender, tapering and inconspicuous.

Mature caterpillar. Body unequally developed, being hunched on the second and third thoracic, and to a less degree on the eighth and ninth abdominal segments; covered with minute, hairless papillae, and with a laterodorsal row of larger compound warts of greatly unequal size, some or all, and especially those of the second thoracic segment, developed as long tuberculate spines, the others forming a raised crown of thickly crowded, short, pointed wartlets.

Chrysalis. Head projecting beyond, and distinct from the thorax. Base of the wing-cases with but a single tubercle; dorsum of mesothorax regularly rounded, carinate; dorsum of abdomen carinate, but on the second segment excessively elevated, so as to form a strongly compressed, rounded prominence; cremaster stout, moderately long.

The insects of this group, which includes some of our most elegant butterflies, are rather above the average size, and usually dark and lustrous, with strongly contrasted white and metallic markings, the latter ordinarily green or blue in tint, the white usually in the form of broad transverse stripes across both wings; the wings are a little elongate, but rounded, and the insects have a strong and often lofty flight. Mrs. Bush thus describes (Amer. nat., xv: 151) the flight and habits of our little known Californian *Najas bredowi*.

"They are warriors, and seem to have a good deal of character. They alighted on the white or black oaks high above, and with the appearance of being on the alert, waited till a large yellow *Papilio* came in sight, when it was chased away. . . . They were shy of light colors. When I had on a light-colored dress, I could not get near one, but with a brown dress, they would alight on it and about my feet. Throwing small pebbles, chips or rocks at them seemed to enrage them, and they would follow anything thrown at them back to the ground."

Like most butterflies, the *Nymphalidi* are principally found in warm climates; their metropolis is in and about the East Indian archipelago, but they are moderately represented in the temperate zones, and are, in general, far more abundant in the Old World than in the New; two genera, at least, occur in North America.

The eggs are globular and deeply pitted, the walls of the pits surmounted at their junction by not very short, slender, fleshy filaments; they are laid singly at the extreme tips of leaves. The larva is very peculiar, having several of the segments conspicuously arched or swollen, and both the body and head covered with unequally distributed compound tubercles; otherwise it is nearly cylindrical; it is solitary in habit, feeding principally on *Caprifoliaceae* or allied plants in the Old World, or on *Betulaceae* or their neighbors in the New; and so far as we know, always hibernating as a caterpillar, constructing for itself a nest from a rolled up leaf, to which, generally when about half grown, it retires for the winter. The chrysalis is furnished with a peculiar, compressed, dorsal projection on the abdomen; and usually has rather conspicuous ocellar prominences, but otherwise it is not angulated. These insects are usually double-brooded, or partly single and partly double. A single genus occurs in eastern North America.

BASILARCHIA SCUDDER.

Basilarchia Scudd., Syst. rev. Amer. Butt., 8
(1872).

Callianira Hübn., Verz. bek. Schmett., 88 (1816).

Limenitis pars Auct.

Not *Callianira* Pér.-Les, 1810.

Type.—*Papilio astyanax* Fabr.

Gay butterflies, a dazzling train
In gold and purple drest.

PECK.—*Noontide*.

Imago (52:9). Head large, densely covered with short hairs, with a slight tuft around the base of the antennae. Front moderately full, slightly hollowed above, considerably protuberant in the middle below, narrower than the eyes, distinctly broader than high,

the middle of the upper border projecting as a narrow tongue backward between the antennae, the lower edge convex, not very abrupt. Vertex very tumid, subglobular, rising just above the level of the eyes, about as broad as long, broadly convex both in front and behind; upper border of the eye roundly angulated opposite the middle of the posterior half of the vertex. Eyes large, full, naked. Antennae inserted in the middle of the anterior half of the head in a deep, broad pit, separated from each other by a slender extension of the front; nearly half as long again as the abdomen, composed of from forty to forty-three joints, the last fourteen or fifteen gradually expanding into a nearly uniform club, scarcely twice as thick as the stalk, the last joint abruptly conical with a slightly produced tip; transversely circular, the club a little depressed, furnished on its lower inner face with four equidistant carinations, some of which run quite, others nearly, to the very base of the antennae. Palpi compact, moderately stout, about half as long again as the eye, the apical joint scarcely one-fifth the length of the penultimate; heavily but compactly scaled and furnished with short, nearly recumbent hairs, with a few longer more erect ones on the outer half of the upper surface of the middle joint. Papillae crowded, edge outward, on outer edge of apical fifth of tongue, apple-seed shaped, appressed and slightly arcuate, tapering more gently toward base, apically rounded, but truncate, and cup-shaped at tip, the rim entire; the cup bearing a slender, bluntly pointed central filament.

Prothoracic lobes pretty large, tumid, fabiform, nearly as long as high and nearly three times as broad as long, slightly appressed, well rounded. Patagia but little convex, nearly four times as long as broad, well rounded at base, tapering gently over the basal two-thirds, apical third tapering more slowly to a very bluntly pointed apex and bent outward at a slight angle; the whole of the exterior margin and the basal half of the interior slightly raised.

Fore wings (38:9) subtriangular, three-quarters as long again as broad, the costal border broadly and pretty regularly bowed, a little more curved on the apical than on the basal half; anterior third of the outer border strongly and regularly convex, the apex well rounded, the lower two-thirds very slightly and regularly concave; inner border straight, the angle rounded off. First superior subcostal nervule emitted beyond the middle of the outer half of the upper margin of the cell; the second shortly before the tip of the cell; the second inferior nervule arising one-third way down the cell; the latter a little more than one-third the length of the wing and two and a half times longer than broad. Median nervure connected opposite its last divarication with the vein closing the cell.

Hind wings: costal border pretty strongly convex at the base, beyond scarcely bowed; outer border pretty regularly and strongly rounded, usually produced somewhat (♂) or sometimes only and to a trifling extent (♀) in the upper median interspace; both angles so rounded that they are inconspicuous; whole margin more or less crenulate; inner border pretty strongly convex at the base, beyond straight or nearly straight to the tip of the internal nervure, just beyond which it is a little emarginate; the internal area guttered as far as the submedian nervure, from the base to the middle of the same, thence to the emargination of the inner border. Precostal nervure bent outward, originating opposite the divarication of the subcostal from the costal; cell entirely open.

Fore legs small, cylindrical, the tibiae scarcely half the length of the hind tibiae; tarsi about three-fifths (♂) or three-fourths (♀) the length of the tibiae; either simple, the joints scarcely discernible, very bluntly rounded at tip (♂); or, distinctly five-jointed, the first three-fifths the length of the entire tarsus, the others decreasing slightly and regularly in size; the first three armed at the tip on the under surface with a pair of minute, very slender spines; apical joint ovate, bluntly pointed, terminated by a minute, short, central spine (♀). The whole leg is furnished with laterally spreading hairs, much more abundant in the male than in the female. Middle and hind tibiae of about equal length, furnished on either side beneath with a row of rather short, slender spines, and on the upper portion of the inner surface with many others, irregularly disposed; spurs long and very slender. Basal joint of tarsi fully as

long as all the others together, while they are nearly equal among themselves. and all are armed beneath with four rows of spines similar to those of the tibiae, the terminal ones of the outer row on each joint slightly longer and a very little curved. Claws rather delicate, very strongly curved, a very little compressed, finely pointed. Paronychiae very slender, equal, slightly curved, nearly as long as the claws. Pulvillus subglobose, the extremity much broader than high.

Male abdominal appendages: upper organ; body pretty broad and stout, gently arched above both longitudinally and transversely; hook as long as the body, curved a little downward, broad at the base, rapidly narrowing and depressed on the basal half, slightly compressed on the apical half, pointed and more strongly compressed at the tip. Clasps pretty stout, broad and nearly equal on the basal half, beyond narrowing pretty rapidly, nearly three times as long as broad; the interior finger free only in its upper half and extending beyond the upper edge of the clasp, although this is more or less prominent at the same point, as is the lower edge at the base of the finger; the apex of the clasp not pointed, but armed with a few teeth.

Egg. Nearly spherical, but a little broader than high, broadly flattened at base, the apex slightly depressed. Surface broken up into pretty large, hexagonal cells, having very high and very thin walls, which are furnished at every angle with a long and slender, tapering, outward projecting, delicate spine or stiff filament. Micropyle small, formed of minute, roundish, angular cells of irregular shape, bounded by heavy rounded walls.

Caterpillar at birth. Head uniform, unprovided with prominences, uniformly rounded, a little and narrowly excised in the middle of the summit, rather squarely docked below, rather broader than high, broadest a little above the ocelli, above rapidly narrowing in a broad curve, furnished with a very few, very short, bristly hairs, thickened at the tip and seated on minute warts, mostly occurring around the outer hinder edge; triangle higher than broad, reaching very nearly half-way up the front. The four ocelli of the front row arranged in a pretty convex series at equal distances apart. Labrum but little excised in front. Body uniform in size, quadrato-cylindrical or a little flattened above and on sides, the second thoracic segment slightly the largest, all studded with numerous little papillae, the subdorsal ones of the second thoracic and seventh abdominal segments barely larger than the rest, but not elevated at base as in the mature larva: the papillae are stellate and disposed in both transverse and longitudinal series, the transverse series corresponding to the following subdivisions of the segments; each segment is deeply cut by a transverse incision in the middle and another less deep in the middle of the hinder half; each of these hinder subsegments bears a transverse series of simple papillae, while the front half has series of larger papillae which become conical mammae in the laterodorsal region, and especially on the second and third thoracic and seventh abdominal segments.

Mature caterpillar. Head moderately large, each hemisphere well rounded, at maturity separated from the other at the suture by a broad and rather deep channel; and produced at the summit into a rather high arch, flattened behind, deepest beneath, the sides scarcely rounded, broadest over the whole lower half, tapering upward, taller than broad; the triangle very small, taller than broad, reaching about one-third up the head, suture of division starting from the middle of the front, its two arms diverging at once at nearly right angles until they are very nearly as widely separated as the base of the triangle, toward which they then turn in a slightly sinuous course. The whole head is profusely and distinctly punctured and covered with frequent, large, conical tubercles, plump but higher than broad and curving a little downward on the front, forward on the sides and summit; at maturity those of the posterior edge of the head are larger and slenderer than the others, and the uppermost ones support little ones on their sides, but none are so great as one on the anterior summit of each hemisphere, where it grows larger more rapidly than the others, and finally becomes a very large, heavy, compound, warty, club-shaped tubercle; all of these tubercles emit a very short, delicate hair. Antennae having the first joint broad and mammiform, the second stout but as long as broad, the third much smaller, cylindrical,

squarely docked, about three times as long as broad and bearing at its outer extremity a fourth exceedingly minute joint, less than twice as long as broad, cylindrical, squarely docked; the third joint also emits a fine, long hair from the apex; ocelli, at least in the adult, five in number, four of them arranged in a broad, regular curve, its convexity forward and a very little downward, the upper three at equal distances, separated from each other by less than their own width, the fourth farther from the third than the latter is from the first, the fifth between, behind, and at equal distance from, the third and fourth; they are of about equal size. Labrum quite small, nearly twice as broad as long, in front excised very deeply at right angles, the outer edge well rounded. Mandibles very small but rather stout, the edge square and exteriorly smooth, interiorly corrugated. Maxillary palpi four-jointed, the penultimate longer than broad, cylindrical, rounded at tip; the last minute, hemispherical. Tip of spinneret long, conical.

Body subcylindrical, with the dorsum depressed a little, and the sides slightly compressed and sloping; unequal, the first thoracic segment being greatly constricted, much smaller than the head, the other thoracic segments tumid both above and on the sides, larger than the others, which do not taper, the last abdominal segment a little elongated and hunched posteriorly above; the dorsum of the second abdominal segment is also broadly hunched and tumid, as is also to a less degree the eighth abdominal segment. The body is furnished conspicuously with a laterodorsal row of compound tubercles, one in the middle of each segment behind the first thoracic (generally elevated to a greater or less extent on mammiform protuberances) even on the segments which are not specially tumid, but unequally developed, being quite small and sessile on the third thoracic and the first and third to sixth abdominal segments, spreading out into a corona of conical blunt wartlets, larger, more spreading, and made up of more numerous (and very numerous) conical spinelets, but still sessile, on the third thoracic and second and seventh abdominal segments; on the eighth abdominal segment it is still larger, clubbed-shaped, sessile, on the ninth abdominal a little smaller and longer, club-shaped on a very short pedicel, while on the second thoracic it is developed as a movable, long, nearly equal, coarsely tuberculated, heavy spine, longer than the diameter of the body, and presenting a most striking appearance, hardly to be paralleled among butterfly caterpillars. Between these laterodorsal rows the dorsum is furnished with from 12-16 minute conical warts on each segment, each giving rise to a very short hair, arranged in transverse rows, mostly on the posterior portion of the segment, and never placed on the dorsal line. The sides of each segment are furnished with about as many more similar ones, and also with a row of suprastigmatal, central, small, low, hemispherical warts, one to a segment, each bearing little raised points, and an infrastigmatal row of similar but larger tuberculous warts; the basal fold of the legs and prolegs are also abundantly supplied with little warts. Spiracles pretty large, obovate. Legs not very long, moderately stout, the joints scarcely tapering but successively smaller, each slightly broader than long; claw very small, slender, slightly curved. Prolegs very short and stout, fringed externally at tip with a row of closely set, small, elongated warts, each bearing a long hair. Hooklets very small, slender, compressed, strongly curved, closely set, forming about three-fourths of a circle, open outwards, from 30-35 in number on the ventral legs, arranged in a single row.

The tubercles of the body become more prominently developed from stage to stage, just as those of the head been described as doing. In the second and third stages the nearly uniform character of the armature of the first stage is retained, the whole body bristling with transverse rows of thickly crowded raised points, which afterwards either disappear or change to minute wartlets.

Chrysalis. Viewed from above, head and prothorax tapering but slightly; ocellar prominences continuing the body-curve, ridged rather heavily on the lateral and lower margins, the lower margin roundly and rather deeply excised in the middle third; inferior face of the head a little hollowed or sunken; on a side view the ocellar prominences are straight and horizontal on the inferior border, broadly curved, and below perpendicular, on the anterior border. Mesonotum high, pretty strongly and regularly arched, but

for the median carination, which is distinct throughout but prominent behind. Edges of wings greatly elevated and thickened throughout. First to the seventh segments of abdomen with a distinct median carina, the prominence of the second segment very high, appressed at base anteriorly, on a side view very strongly arched and very regularly rounded, on an end view sloped like the roof of a house, at an angle of about 45° , a little pinched at summit; eighth abdominal segment having its anterior border a little thickened and raised between the subdorsal regions, and bearing centrally a pair of low, rounded, laterodorsal warts. Preanal button consisting of coarse, grooved, slightly curving, longitudinal, lateroventral ridges, each terminating anteriorly, where they approximate slightly, in a smooth, rounded, anteriorly directed, cylindrical, equal tubercle longer than broad; the space between the ridges is tumid with a posterior, ventral, linear depression. Cremaster viewed from above very stout, as long as the two previous segments, longer than broad, tapering a little with a lateral and terminal, continuous, coarse, equal, corrugated ridge, those of the two sides parallel; viewed from the side it is twice as long as broad, nearly equal, expanding a little at the tip; area of hooklets square with lateral prolongations at each corner, longest on the ventral ones. Anal hooklets not very long, the basal half straight, the apical curving strongly, bent at right angles but well rounded and enlarging considerably, then diminishing rapidly to a point which is so much curved as to be directed toward the stem. Body transversely and rather delicately striated, distinctly on the third to the seventh abdominal segments, less distinctly and rather more coarsely on the thoracic segments; basal and terminal abdominal segments, especially the latter, somewhat corrugated, the prominence of the second segment principally smooth.

This genus, including at least five species, is peculiar to North America and occurs everywhere, except south of the United States, on the extreme Pacific slope* and in the furthestmost arctic regions. Three or four species occur in the southern half of the continent, another inhabits the north, and one, so far as known, is restricted to the Rocky Mountains. One species only is found throughout New England, another in the southern portion, and a third occupies the northern half or more. On the extreme Pacific coast, as in Europe, the group is almost everywhere replaced by the very closely allied genus *Najas*.

The butterflies of *Basilarchia* are moderately large in size and differ greatly in appearance, since two species, or even three, according to Doubleday and Wallace, mimic in attire butterflies of very different groups; but in all their earlier stages the three New England species resemble each other so intimately that even one well acquainted with them can with difficulty distinguish the separate forms. Owing to this great variety among the butterflies it is difficult to give any general description of their colorational pattern; but the normal types are a deep, dark, rich purple or blue black, with a very broad, common, extra-mesial white band, broken by dark nervules, and followed exteriorly on the hind and sometimes also on the front wings by small reddish spots, and these again by a common submarginal series of pale bluish or whitish lunules or spots—all the marginal markings being larger beneath than above; midway between the extra-mesial band and the apex of the fore wings is a second short, transverse

* One species reaches it near our northern boundary,

band of white spots; the basal portion of the wings beneath and especially of the hind wings is marked with clouded coloured spots. They differ from butterflies of the genus *Najas* mainly in the broader mesial band (which is generally absent from *astyanax* and wholly wanting in *archippus*) and in the marginal markings.

The eggs are very curious, being nearly globular, covered with high walled, hexagonal cells, from each angle of which arises a rather long, stiff, tapering filament. According to Daube and Gärtner, those of the European genera *Limenitis* and *Nymphalis* are similar.

The larvae are exceedingly grotesque in appearance and present at the same time a very threatening aspect; the head is surmounted by a pair of warty globular tubercles, and the fore part of the body is considerably hunched and tuberculated, bearing, on the middle thoracic segment, a long, stout, clubbed horn, bristling with short barbs; the hinder segments of the abdomen are also hunched and tuberculated, and the whole body is so strangely and irregularly mottled with cream color and various shades of green as to add greatly to the fantastic effect. They may be distinguished from the caterpillars of *Najas* by the contraction of the first thoracic segment, the absence of profusely distributed minute papillae over the body, and the reduction of all the tubercles of the third thoracic and second, seventh and eighth abdominal segments, the latter less marked in the southern *B. eros* than in our other species.

The caterpillars of *astyanax* and *archippus* resemble each other most strikingly, and probably in their earlier stages it would be almost impossible to distinguish them. The best points of difference will be found in the summit tubercles of the head, and the elongated spinous tubercles of the second thoracic segment. The former is almost globular in *astyanax*, no higher than broad, and irregularly encircled near the summit with a few very small conically raised points which also are no higher than broad. In *archippus* it is higher than broad, the sides straight, scarcely swollen, and bear larger conical pointed warts higher than broad. The thoracic spines of *astyanax* are much shorter than those of *archippus*, but of about equal size; they are more closely studded with tubercles, there being scarcely any spot unfurnished with them, while many of the tubercles of the spine of *archippus* are distant from each other by more than their own diameter, the tubercles themselves stouter and shorter, being seldom longer than broad, while in *archippus* they are usually considerably longer, and often more than twice as long. See, however, *Can. ent.*, iii: 52, 117.

The above paragraph was written many years ago, since which time I have been unable to examine more caterpillars of *astyanax*, but many of *arthemis*, which agrees better with it than with *archippus*, and may invariably be distinguished from the latter by the characters given in the table beyond. Unfortunately I have not been able to make any direct comparisons between *arthemis* and *astyanax*.

The juvenile caterpillars differ from those fully grown in having a smooth head and uniformly cylindrical body, subquadrate in cross section, studded with numerous, equal, stellate, regularly disposed warts.

The chrysalids are also of a peculiar shape, having the anterior half of the body curved, the head thrust forward and downward and the thorax considerably arched, while the abdomen scarcely tapers except at the bluntly rounded extremity, and bears, on the second segment, a strongly compressed dorsal projection, oddly resembling a "Roman" nose. It appears to be slenderer than the chrysalis of *Najas*.

The species of *Basilarchia* differ from each other in the chrysalis state again very slightly, and can with difficulty be distinguished; an examination of a considerable number of specimens shows me that there is considerable variation in the same species in the form of the dorsal tubercle of the second abdominal segment; its anterior curve is perhaps a little more produced in *archippus* than in the other species. In *archippus* the basal wing tubercle is produced to a minute, conical, pointed wart directed outward; in *arthemis* it is somewhat pointed but directed a little backward; while in *astyanax* it is rounded off or partially suppressed. Viewed from above the portion of the cremaster lying within the marginal ridge is much longer than broad in *archippus*, while in the other species it is nearly square. *Astyanax* is perhaps a little stouter than the other species, and more constricted at the metathorax on a dorsal aspect than either of the other two. See also Riley, *Can. ent.* iii: 52, 117, and Lintner, *Proc. Ent. soc. Phil.* iii: 63.

The species are normally multiple brooded, the larva of the last brood and sometimes of the preceding, when in its second or third stage (sometimes in the fourth), constructing for itself a hibernaculum out of a leaf and wintering therein; it quits this in the spring before the leaves are fairly out and the earliest butterflies appear, in New England, in June. A second brood in August is usually less abundant than the preceding, so that then the insects probably have a history similar to that of *Nymphalis*, as given below.

As before stated, some species of this genus, when in their perfect state, are believed to mimic the coloration and design of other butterflies. Doubleday was the first to point out this curious resemblance (*Gen. diurn. Lep.*, ii: 275); *B. astyanax*, he says:

Is remarkable for entirely wanting the white fasciae so characteristic of the genus, the upper surface of the wings being black, the extremities covered with blue scales, with several subapical rows of black lunules; on the under side it is glossed with purple, and elegantly ornamented with bright orange spots at the base and beyond the middle of the wings. It bears, in fact, a singularly strong analogy in its colours to the North American *Papilio philenor*, whilst the allied species, *L. disippus*, (*P. archippus* Cramer) bears an equally strong analogy to *Danaüs archippus* [*plexippus*] in its dark orange-red colour, with a black border to all the wings, spotted with white.

This subject is fully discussed elsewhere in this work.

The butterflies of this genus, including some of our showiest forms—the very queens of butterfly society—show their depraved taste in a fondness for the ordure of animals fallen in the road. Their flight is lofty and sailing and they are usually wary and easily alarmed. When resting in the sun and especially when upon the leaves of trees they often remain a long while with broadly expanded wings. When in the shade their wings are folded back to back, and the antennae are spread at an angle of about 60° ; the latter are very nearly straight, but slightly bent, with a broad curve at about the middle, so as to bring the tips a little nearer together. When walking, and occasionally when at rest, they feel the surface before them, sometimes with both antennae together, sometimes alternately.

There is no American genus of butterflies, the habits of which in the earlier stages are more interesting than those of *Basilarchia*. The eggs are laid upon the extreme tip of acuminate leaves (the allied families of *Cupuliferae*, *Betulaceae* and *Salicaceae* are the favorite food plants of the larva), and the little caterpillar devours first that end of the leaf, sparing the midrib, to which it always retires after a meal. The further performances of the creature have been so well told by Mr. Edwards, that I give his account of them in an abbreviated form (*Butt. N. Am.*, ii). The end of the rib is no sooner laid bare than it is coated and wound with silk, of the use of which these caterpillars are exceptionally free, and to this extremity are fixed bits of bitten leaf as small as grains of powder; at first there are but two or three in line, but the number is afterwards increased, and they probably serve to stiffen the perch and prevent its curling as the rib dries. “It is constantly strengthened by additions of silk, the larva almost invariably, as it goes back and forth from its feeding ground, adding threads and patching the weak places.” When not feeding the caterpillar always occupies this perch, the head outward; “its usual attitude is a twist, the ventral legs clasping, but the anterior half of the body is bent down by the side of, and somewhat under, the perch.” It has the curious habit of accumulating little scraps of leaf at the base and under side of the perch into an open packet, and this is moved as the leaf is eaten, so as always to be close to the cut edge of the leaf. This edge, in narrow leaves, and at first in broader ones, is kept nearly square by eating first on one and then on the opposite side of the leaf. Occasionally a canal is eaten from the edge of the leaf, parallel to the eaten edge all the way to the midrib; as the bit of leaf thus left unsupported begins to droop, guys are spun from it to the solid leaf on the opposite side of the canal and to the midrib; it is then eaten away from the leaf, and the triangular bit remaining falls hanging by its threads and swings to the base of the perch or is pulled there by attaching successively shorter threads. The packet is left behind and not increased after the second

stage is passed, and the caterpillar no longer frequents the perch, which has become too weak for its weight; it now prefers the footstalk of leaves or twigs.

But if the proper season has now arrived, it begins by this time to construct its winter quarters, of which Edwards has in the same place given a very full account, upon which I will draw freely. In most cases the caterpillar finds that the bit of leaf on which it is then resting will answer its purposes and is already of the proper shape and size, but not infrequently it attacks a new leaf, which it does by cutting channels down the lobes very much as we should use a pair of scissors, to remove the superfluous portions, leaving finally a fiddle-shaped piece at the base. This is then smeared with silk on the upper surface, the edges brought as nearly together as possible, the interstices thoroughly covered with silk, and the cylinder resulting is found exactly to fit the caterpillar's body, now shrunk somewhat from its severe labors; the leaf stalk is attached very firmly to the stem by threads passing very many times entirely around it, and the hibernaculum is ready for occupancy.

The caterpillars are not only grotesque in appearance, but in habit; they move about with little starts, very ludicrous to observe; they often rest, when sulking, with their front parts strongly arched, the front of the head resting on the leaf, the tips of the thoracic tubercles just touching the same, and the tail aloft; at other times they rest the side of the head on the leaf, or by the side of the stem on which they are resting, as if weary of this world.

In order to call attention to points in the history of our own species which resemble the histories and habits of the allied European genera of this group, I will add a brief notice of them. Gärtner writes of *Nymphalis aceris* (Stett. entom. zeit., xxi: 296-7):—

As soon as it leaves the egg, it begins to eat through the leaf [of *Oronus vernus*] laterally as far as the midrib, which, together with the tip of the leaf, it leaves untouched; at its next meal it attacks the opposite side of the leaf, and so on alternately, gradually approaching the base; after each meal it crawls over the untouched midrib to the very tip of the leaf, where it takes a siesta, its head directed onward; and thus it continues through three stages. After the third moult, however, it changes altogether both its resting place and manner of life; it now attacks the leaf at the base, no longer eating toward the midrib in regular furrows, but biting out great morsels, penetrating deep down on both sides, so that the leaf is weakened and hangs downward, held in place by only a few filaments, or by the threads of silk spun by the caterpillar; it then quits this leaf for another, which it eats in the same manner, until at last the tree is furnished only with dangling dead leaves, in one of which the caterpillar hibernates. These wintering larvae give out butterflies in the spring and the eggs laid by them hatch in eight days; in fifteen or twenty days the larvae are all grown, but less than half change to chrysalids and disclose butterflies in August; the others stop eating and hibernate together with the larvae produced from eggs laid by the August butterflies; and in the following spring both produce butterflies at the same time!

The butterfly appears, therefore, to be at the same time both single and double brooded. Dr. Breyer's account of *Limenitis sibylla* is as follows (Ann. Soc. ent. Belg., v: 62-63):—

The egg is laid near the tip of honeysuckle [*Lonicera*] leaves; two are rarely placed on one and the same leaf, and the leaves of small plants are preferred by the female. The little caterpillar makes its first attack on the leaf on one side of the tip, and eats very moderately, so that the leaf on which it was born answers all its needs until autumn, by which time it is reduced to two small flaps next the pedicel. To hibernate, the caterpillar takes up its station on this pedicel, and pulls the two lobes of the leaf over itself to form a small tube. The pedicels which serve the purpose of this shelter do not fall during the winter, and collecting them in the spring is the quickest way of obtaining the caterpillar. The latter is of a dirty yellow color, much contracted, and armed with prickly prominences. In early spring it quits its shelter, eats something, changes its skin, assuming the livery in which it is well known, becomes voracious, grows rapidly and conceals itself closely on the plant.

According to Meyer Dür, from two to four caterpillars of this species are usually found on a plant, and the butterfly flies in July. Boisduval states that there is sometimes a second brood in September.

Of another species of *Limenitis*, *L. camilla*, Boisduval says that the egg, which he compares to a chestnut burr, is laid singly on the upper surface of leaves, and that such caterpillars as hatch in September, pass the winter without moulting, under a little web spun at the bifurcation of a twig.

According to Dorfmeister (Verhandl. zool.-bot. ver. Wien, iv: 483-486), the food of *Najas populi*, a European insect the most nearly allied to ours, is the aspen, *Populus tremula*. The habits of the young larva are described as precisely similar to those of *Nymphalis*, except that the midrib of the leaf is carefully covered with silk, a precaution which such a mode of life would appear to render indispensable, and which is found in *Basilarchia*. The moment a meal is finished, or the caterpillar is disturbed, it travels back over its siken bridge, spinning as it goes, and takes up its position at the tip. It invariably remains upon the leaf where it was born until after the first or second moult. It constructs the same packet of ruffraff as *Basilarchia*. The species of this genus are all single brooded and hibernate as early as the seventh of August, after the second or third moult, constructing a hibernaculum somewhat similar to that made by the caterpillars of *Basilarchia*, of a bit of leaf rolled into a cylinder and fastened by its longer axis flat upon a twig. Specimens observed by Dorfmeister continued to eat for a week or two after they had taken up their new residence, returning to it after every meal. One specimen was still in winter quarters on the seventeenth of May, but was found in the pupal state on the fifth of June, and disclosed the butterfly on the seventeenth. It would be interesting to learn if this is the kind of hibernaculum made by our Californian *Najas*.

EXCURSUS VIII.—THE MEANS EMPLOYED BY BUTTERFLIES
OF THE GENUS BASILARCHIA FOR THE PER-
PETUATION OF THE SPECIES.

. . . nature never lends
The smallest scruple of her excellence,
But, like a thrifty goddess, she determines
Herself the glory of a creditor,
Both thanks and use.

SHAKESPEARE.—*Measure for Measure.*

THE power of reproduction conceded, the universal instinct for self-preservation is the fundamental and controlling principle by which the perpetuation of any kind of animal is successfully reached. The uncontrollable maternal instinct of self-sacrifice existing in some animals alone overmasters it, and this exists only in the higher animals, which, compared with the great mass, are but few in number; and is then in most cases called into play only when the creature's life-work is nearly finished. No such instinct occurs among butterflies, nor is in any way likely to be found, so that "self-preservation" and "perpetuation of the species" are here, at least through all but the closing days of life, practically equivalent terms. The "struggle for existence" in the species and in the individual are largely convertible terms.

This struggle is the perpetual inheritance of the individual. The individual inherits alike its structure and its habits of life, which latter are very largely, perhaps almost absolutely, dependent on its structure; its tastes and its propensities, its fears and its devices to circumvent its enemies; all its instincts, which are to a great extent, possibly wholly, the entailment of ancestral habits; its very attitudes, whether at rest or in motion. Its advantages and its disadvantages are thus alike its legacy; so too the peculiar means it employs to disembarass itself of these disadvantages. This is especially and more immediately true of the insect in its earlier stages, where freedom to change the immediate surroundings is exceedingly limited or altogether impossible, except so far as there is foresight, or an instinct marvellously akin to foresight, on the part of the creature in an antecedent stage.

It is of more than usual interest to study the means of self-preservation in the genus *Basilarchia*, since there is hardly another genus of our butterflies where throughout its entire life the insect is apparently so exposed to its enemies. They are all, of their kind, conspicuous objects even to our dull eyes, and more than that they are, with the exception of the chrysalis, always found in unusually conspicuous situations. How then do they manage to escape their keen sighted foes, the birds; or their wakeful, indefatigable, persistent enemies among the insect tribes,—ichneumons, ants, wasps, flies, mites, and spiders?

Take first the egg-stage. Every one who has attempted to rear butterflies knows what immense destruction falls to the lot of any species at this stage of its life. Ants and spiders look on them as delicacies made for their delectation, and there is a whole group of tiny Hymenoptera, almost too small to breathe, one would think, mere specks, which live solely upon insects' eggs, piercing them with their egg-darts, their progeny living imprisoned and feeding on the contents until they have run the cycle of their changes. Some attack whole batches of eggs, laying one egg in each, so that one parasite may destroy the entire brood of one butterfly; others lay their all in one or two eggs, and it is to this class that those belong which sting the eggs of Basilarchia. How does Basilarchia escape this danger? In the first place, the mother rarely lays more than one egg in one spot or even on one bush, though as many as a dozen or two may occasionally be found, where the butterfly's numbers are great and they are growing as it were imprudent. Then it must be remembered first that,—to judge from the latest researches—these parasitic flies must be guided less by vision than by touch; and second, that most insect eggs are laid on the broader parts of the leaf on which the young will feed; it is here that the parasite will range in quest of prey; but the eggs of Basilarchia are rarely found except at the extreme tips of leaves, and in addition the leaves of the food-plants concerned are all acuminate, some to an excessive extent, as in some of the poplars and birches. When the parasite has, however, found an egg, it may well be inquired whether she would not be deceived by it. It differs from the eggs of all our other butterflies, in that it is besprinkled with little flexible filaments, for all the world like the hairs of some leaves. Or if the clothing of the eggs did not deceive, she might even then find it difficult of attack, for minute as these parasites are, less than half a millimetre long, their bodies would extend across at least three of the polygonal cells which regularly stud the surface of the egg, and which send forth these little filaments at every angle, so that poor bewildered madame must struggle through a weary chapparal before she can attain the barren grounds at the summit and find a spot to readily insert her sting. Yet that she succeeds is only too evident to the collector; the larger part of the eggs obtained in the open field which have fallen into my hands have been parasitized.

This is its but too partial defence against its special enemies. But how about those wandering buccaneers, the ants, mites, and spiders? These labor under the same visual defects as the direct parasites, or sometimes greater ones; and the position of the egg, remote from their usual hunting ground, must serve as no inconsiderable protection; how great, there are hardly means of measurement. Their greatest protection from these savages, which cannot fly but must wander ceaselessly about on foot in search of prey with satanic energy, is undoubtedly in the fewness of their

number on one plant. The spider that finds two eggs of a *Basilarchia* in one day must be an excellent hunter.

Escaped at last from these dangers, which only lasted at the most ten days, the caterpillar crawls forth from its prison and begins its active life. It is a scrawny juiceless looking thing, all covered with warts, and less than any other newly born caterpillar, would seem a tempting morsel even to an ichneumon or a spider. Yet both make havoc with it at this time. To a wandering ichneumon contact with an empty egg-shell would probably mean, as a result of its inherited wisdom, that some nice young caterpillar was about, and the neighborhood would be all the more thoroughly ransacked. Caterpillars devouring their egg-shells, and so not leaving this "scent" behind them, would oftenest escape, and by degrees this habit would be perpetuated and fixed; and so it is here; almost invariably the caterpillar hastens to destroy its former prison walls, which it devours to the very base, too closely glued to the leaf to be eaten; probably it breathes more freely when that is done.

But where does it now find itself? Its food at its very feet,—yes; but in the most exposed position possible. Atop the extreme tip of one of the outmost leaves of a spray that projects most freely into the sun and air, just where it can most easily be seen by the passer by; this seems to be the case nine times out of ten. It is, however, probably the safest place from the prowling spiders; but surely not from its flying enemies. What does it do? Retreat down the leaf? That would be only to exchange one danger for another, and on its way to a presumed place of safety it would be more sure of detection, because a moving object in nature is always most easily noticed. No, it eats the nearest bit of leaf down to but not including the midrib, first on one side and then on the other, and then retires to near the tip of the midrib, to digest it; subsequent meals it takes in the same way, moving with excessive deliberation along its narrow path and retiring always to the same spot. On this perch it cannot be seen from below, and from the sides and above seems almost or wholly a part of the denuded midrib to which it clings; more particularly when the leaves are in motion by the wind, as they usually are on the trees on which it feeds, particularly in the case of the aspen.

That this mode of life is on the whole an advantage to it is rendered probable from the fact that there are two cases known, in which it is followed very closely by caterpillars of a moth (*Notodonta*), feeding on the very same plant as species of butterflies with this habit (one in Europe and one in America); while the caterpillars of *Basilarchia* employ a further device, the actual import of which has been a puzzle. Very soon after birth, when it has eaten but a very few swaths down the leaf, the little fellow constructs a small and loose packet from minute bits of leaf and other rejectamenta, loosely fastened to one another and to the midrib,

close to but scarcely touching the eaten edge of the leaf; and as fast as the leaf is eaten, it removes this packet (continually added to until it becomes about as big as a small pea), farther and farther down the midrib away from its perch, always keeping it near the eaten edge. It should be noted that it is so loosely attached, the bits of leaf at all possible angles, that it is moved by the least breath. Meanwhile the caterpillar has been growing larger and more conspicuous and thus in greater peril from its enemies. There are two possible services that this odd packet may render. A spider wandering over the leaf and observing its motion may seize it and thinking it has a prize hurry away with it and leave its architect unharmed. This seems to me rather a strained suggestion, for a wandering spider would probably proceed to investigate it on the spot. Another explanation seems more probable. It should be remembered that the leaves preferred by these creatures as food are mostly such as are easily shaken by the wind, and as the caterpillar moves with the leaf and with all the surrounding leaves (in a continual fluttering in the case of the trembling aspen, and to a less degree in the other food-plants) this of itself is a protection to it, as it would more readily escape observation as an object distinct from the leaves, all being in motion together; but on the more stable leaves, like the willow and especially the Rosaceae and the oaks, the motion in a feeble wind would not be sufficient to be serviceable, and here at least the packet comes into play. An object in motion among others at rest is a most noticeable thing, a fact well recognized among animals, as a host of them show when they fear being seen. This packet attached by loose silken threads moves, as stated, with a breath of wind and so would *distract attention* from its architect near by, who has taken pains to place it at the farthest remove from his perch, while still (to avoid undesirable steps) on his daily track. If this be really its object, it is surely one of the oddest devices in nature.

The species of Basilarchia all pass the winter while in the caterpillar state and but partly grown. The caterpillar has moulted at least once (devouring its cast-off clothing, by the way, doubtless that it may not attract attention) and has to prepare against the inclement season. This it does in a very shrewd way, which is all the more remarkable because no trace or semblance of it is seen in caterpillars of the broods that attain their entire growth in the same season. When the proper time approaches, warned thereto possibly by the dryness of its food, or by the cooler nights, the caterpillar constructs a little nest, sometimes from the still unfinished leaf on which it was born, sometimes from one which it prepares specially at greater pains; this is done by eating away or biting off the unnecessary parts, and leaving on either side of the base of the leaf little flaps just large enough, when drawn together, bottom side up and meeting above, to form a cylinder into which it can squeeze; a projecting shelf is also left

beyond the opening, on which it may stand when ready to crawl in, and upon which it may back out in the spring; the whole of the inside and the upper surface of the shelf are then plastered over with a dense coating of brown silk and the flaps drawn together; more than that, with strangest foresight, the petiole of the leaf is thoroughly fastened to the stem by numberless threads passed carefully and tightly around both; into this cylinder it then crawls head foremost, completely filling the cavity, closing the bevelled hinder opening with the sloping tuberculate and sharpened terminal segments, sure to find itself there when the long night of winter is passed. No, not quite sure, for wasps or some other strong predaceous insects will tear this fine castle open and destroy its single occupant. Whether it is an additional safeguard or not, it is an instructive fact that, at least where the winters are most severe, nearly all these hibernacula are made out of leaves so near the ground that the snow covers them with its warming mantle; and what is more, in certain cases they so closely resemble the winter buds and bursting leaves of the new year that they must sometimes deceive their prowling foes of the early spring.

Shortly after it appears again in the spring and has fed on the tender buds and just opening leaves, it moults again, usually upon the shelf of its hibernaculum, but no longer devours its skin, as it quits the immediate neighborhood. It now changes its livery as well and is a most extraordinary looking object, withal very conspicuous. Dark and light green and cream color strive for the mastery and leave it streaked and blotched so that it bears no inconsiderable resemblance, in color at least, to the droppings of some birds, a circumstance which doubtless serves it as some sort of protection. Its body is humped and the bosses bear tubercles which give it a somewhat repulsive aspect; especially a pair a little behind the head are raised aloft thickly studded with prominences, the effect of which is heightened by the creature's habit of arching this part of the body, bending its head to the ground and raising aloft its hinder part, also studded with roughened processes. Altogether it is a rather hideous beast. Then too, if disturbed, it raises the front half of its body from the ground and uses it as a kind of whip-lash, throwing it to one side and the other with great violence. When it walks, it moves with a slow and cautious tread, its head trembling as if it had the palsy. All this is doubtless to inspire fear to such enemies as might be tempted to attack it, but to how much avail we can hardly tell. It is certainly attacked in considerable numbers by a parasitic hymenopteron, the young of which live within on the juices of the body and escape from the chrysalis when that is formed.

The chrysalis, helpless thing, probably hangs quite exposed upon the stem of the plant which has given the caterpillar nourishment. We know it almost entirely from those raised in confinement. It has an oddly shaped form, with a great projection on the back like a Roman nose, and

is of a dark green or greenish brown color varied with cream color, and smooth as if varnished. This makes it appear like a hanging lump of bird dung, and so again must often prevent its being picked off and devoured by some hungry bird.

When one that has at last escaped all the perils of its youth finally reaches its full development, it is even more conspicuous and exposed than before. Although now upon the wing and no doubt often able to escape a pursuer by some quick movement, its natural flight is not swift, and its ordinary movements on the wing are a few quick flutters followed by a sailing motion which is most favorable to capture. Its colors differ of course in the different kinds, and they may in this particular be divided into two classes. One affects a deep rich black-blue or blackish purple, and is variegated with light blue and white, the latter partly in the form of bands, on some forming a broad bow across both wings, rendering them most conspicuous and striking objects. They are, too, of a pretty large size, and as they fly mostly in the neighborhood of copses or along shaded roadsides or forest roads, they seem to render themselves by the contrasting back-ground as conspicuous as possible. Another class is of an orange brown color of greater or less depth, while the veins are black, and a black stripe, sometimes accompanied by white dots, crosses the wings. These fly in more open places, more fully exposed to the sun and are scarcely less conspicuous than their fellows. All these butterflies live a considerable time, and indeed the eggs do not mature in the bodies of the females until they have been a fortnight on the wing; and then they do not lay all their eggs at once, or even within a few days, but prolong the operation over many days or even several weeks. To deposit all her eggs therefore, which is the province of course of the female, she must fly amid all the dangers her conspicuous colors offer for about a month, a considerably longer time than the average of butterflies. Previous to egg-laying at least, much of her time is spent upon the ground in company with her fellows, often in great flocks, engrossed in sucking up moisture from the damp earth, from decaying fruits or the droppings of beasts; and so must become a conspicuous and easy prey to her enemies.

What then is to become of this saving remnant of the tribe? How escape from the dangers which it seems to invite? For the individual there would seem to be nothing but chance; but the number of eggs laid under the most favorable circumstances or chances is very considerable; and if only a pair of these finally reaches maturity and is able to fulfil its functions, the number of individuals of the species is maintained. It would seem, however, as if even this chance were small and as if still further protection were needed. And one further protection seems to be afforded in some species in a peculiarity of their life history. Apparently the species of *Basilarchia* are, at least in New England, normally single

brooded; but in not infrequent cases, doubtless more frequent in southern than in northern parts, a second or supplementary brood is formed in one season; as the butterfly lays eggs for some time, and all the females are not born at once, the earliest progeny of the earliest females may not infrequently be able to mature in the same season in time for the production of a second brood. This would seem to be a provision on the part of nature to give the species a better chance. That they need it is perhaps evidenced by the fact that the black-veined orange species, which are almost universally more numerous in individuals than the others, have, in regions where one brood is the normal condition of their fellows, always two broods.

But this is not the only advantage the black-veined orange species have, so that we cannot fairly ascribe their greater numbers to this alone. Their very colors are an advantage to them, for in them they mimic species of Euploeinae, which possess a taste and perhaps an odor offensive to birds and other insectivorous animals; the mimicry is very striking indeed, and is the more remarkable from the fact that the northern species resembles the only species of Euploeinae found in the region it inhabits, while the southern species as well as the southernmost examples of the northern species, resemble another which is more common in the region they inhabit. It is indeed possible that one of the normally colored species of *Basilarchia*, one that has least conspicuously contrasted colors, though resplendent with blue and green, is specially protected by the various other devices we have recounted; for certainly it is itself mimicked by one sex of a butterfly of another very distinct group, viz: *Semnopsyche diana*.

Table of species of Basilarchia, based on the egg.

Height of egg about five-sixths the width.....	<i>archippus</i> .
Height of egg scarcely less than width.....	<i>astyanax</i> .

Table of species, based on the mature caterpillar.

The minute, smooth, lenticular warts very infrequent, not more than twenty above the spiracles on any segment.

Coronal tubercle of head crowned with distinct denticulations interrupting the contour above; principal tubercle posterior to it denticle-shaped, many times higher than broad, independent.....*archippus*.

Coronal tubercle of head rather regularly rounded at summit, but crowned with raised points; principal tubercle posterior to it tumid, but little higher than broad, compound, and at base closely united to the coronal tubercle.....*arthemis*.

The minute, smooth, lenticular warts tolerably common.....*astyanax*.

Table of species, based on the chrysalis.

Cremaster, viewed from above, twice as long as its apical width.....*archippus*.

Cremaster, viewed from above, less than twice as long as its apical width.

Basal wing tubercle rounded off or partially suppressed.....*astyanax*.

Basal wing tubercle produced to a minute point directed backward.....*arthemis*.

Table of species, based on the imago.

Ground color of wings orange.....	archippus.
Ground color of wings black.	
Wings without any white bow.....	astyanax.
Wings with a very broad, conspicuous, common, white bow.....	arthemis.
(Wings with a narrow and faint, bluish white bow.....)	proserpina.)

BASILARCHIA ARCHIPPUS.—The viceroy.

[The viceroy (Scudder); Disippe butterfly (Harris); Disippus butterfly (Riley); stripe-footed limenite (Emmons); Misippus butterfly (Fitch); the dark veinlet (Ross); the banded red butterfly (Maynard); viceroy butterfly (Packard).]

Papilio archippus Cram., Pap. exot., i: 24, pl. 16, figs. A. B. (1779).

Limenitis archippus Butl., Catal. Fabr. Lep., 60-61 (1869).

Basilarchia archippus Scudd., Bull. Buff. soc. nat. sc., ii: 250 (1875); Butt., 100-104, 112, 133, figs. 2, 85, 86 (1881).

Anosia archippe Hübn., Verz. schmett., 16 (1816).

Papilio misippus Fabr., Syst. entom., 481 (1775);—Herbst, Natursyst. ins. schmett., vii: 30-31, pl. 158, figs. 3-4 (1794);—Abb., Draw. ins. Ga. Brit. mus., vi: 23, figs. 22-23; xvi: 24, tab. 4; Draw. ins. Ga. Oemler Coll. Bost. soc. nat. hist., 15.

Nymphalis misippus God., Encycl. méth., ix: 175, 188, 806 (1819).

Limenitis misippus Harr., Hitchc. Rep., 590 (1833); Proc. Bost. soc. nat. hist., vii: 189-190 (1860);—Fitch, 3d Rep. noxious ins. N. Y., 61-62 (1859);—Pack., Guide ins., 261-262, fig. 189 (1869);—Mead, Can. ent., iv: 216-217 (1872).

Nymphalis disippe God., Encycl. méth., ix: 340, 393-394 (1819);—Harr., Ins. inj. veg., 3d ed., 281-282, fig. 109 (1862).

Limenitis disippe Ménétr., Catal. coll. entom. Acad., i: 33 (1855).

Basilarchia disippe Scudd., Syst. rev. Amer. butt., 8 (1872).

Nymphalis disippus Boisd.-LeC., Lép. Amér. sept., 204-205; pl. 55, figs. 1-2 (1834);—Morr., Syn. Lep. N. Amer., 65-66 (1862).

Limenitis disippus Westw.-Hew., Gen. diurn. Lep., ii: 276 (1850);—Emm., Agric. N. York., v: 202-203, pl. 47, figs. 1-2 (1854);—Lintn., Proc. Entom. soc. Philad., iii: 63 (1864);—Saund., Can. ent., i: 94-95 (1869);—Ril., Can. ent., iii: 52-53, 117-118 (1871); Rep. ins. Missouri, iii: 153-157, figs. 68-71 (1871);—French, Rep. ins. Ill., vii: 154 (1878); Butt. east. U. S., 210-213, figs. 59-62 (1886);—Edw., Can. ent., xi: 224-228 (1879); xii: 250-251, fig. 24bc (1880); Butt. N. Am., ii: Limenitis 1: [12-17] (1879);—Middl., Rep. ins. Ill., x: 88, fig. 14 a-d (1881);—Coq., ibid., 162, fig. 59 (1881);—Fern., Butt. Me., 65-67 (1884);—Saund., Ins. inj. fruits, 168-171, figs. 178-181 (1883);—Mayn., Butt. N. E., 9, pl. 2, figs. 9, 9a (1886);—Soule, Psyche, v: 14, 43 (1888).

Papilio jamaicensis minor Rai, Hist. ins., 139 (1710).

Figured by Petiver, Gazophyl., i, pl. 15, fig. 9 (ca. 1700);—Glover, Ill. N. A. Lep., pl. 1, fig. 9 (2 figs.); pl. 22, fig. 15 (2 fig. hibern.); pl. 34, figs. 1, 8; pl. 100, fig. 26 (2 fig. hibern.); pl. 108, fig. 7; pl. A., fig. 11, ined.

[Not *Papilio misippus* Linn.]

Go sip the rose's fragrant dew,
The lily's honey'd cup explore,
From flower to flower the search renew,
And rifle all the woodbine's store:
And let me trace thy vagrant flight,
Thy moments, too, of short repose.
And mark thee then with fresh delight
Thy golden pinions ope and close.

The Butterfly's Birthday.

Truly, she makes a very good
report o' the worm; but he that will believe all
that they say, shall never be saved by half that
they do: but this is most fallible, the worm's an
odd worm.

SHAKESPEARE.—*Antony and Cleopatra*.

Imago (1:5; 11:4). Head velvety black, tinged above in the least possible degree with olivaceous; a pair of small, white, triangular spots on the hinder margin of the head and a pair of white dots next the eye, each set opposite the base of the antennae; a larger, fusiform, narrow, white spot behind each eye. Antennae black, the basal

joints faintly annulated at tip with castaneous, the apical half of the club faintly and narrowly annulated at tip with ferruginous, the last joint (♀) or the last three joints (♂) tinged decidedly with bright ferruginous. Palpi black, the sides, excepting the basal half of the basal joint, covered with white scales, between which appear a few black hairs. Tongue black, its tip fuscous-luteous; papillae (61:28) as long as the width of one maxilla, comparatively slender, four times as long as broad; apical filament of similar shape, slightly shorter than width of papilla.

Thorax black, slightly tinged with olivaceous; beneath, at the extreme base of the costal border of each wing a white dot, and at the base of the wing itself a short, slender, longitudinal, white streak; on the middle of the sides of the middle and hind coxae a pretty large, white spot, the anterior roundish, the posterior oblique and oval; tips of these coxae white; femora black; rest of legs blackish brown, the tips of the middle and hind tarsi edged above with white, whole exterior surface of the fore tibiae and tarsi white; spurs and claws dark reddish; spines black.

Wings above varying in color from a dull yellow orange, tinged slightly with brown, to a cinnamoneous orange, or even, in the southern states, to a dark cinnamon; the veins are all edged with black. *Fore wings* having the costal margin slightly less bowed than in our other species, and the middle of the outer margin slightly less concave. Third superior subcostal nervule originating midway between the base of the second, and the centre of the interspace enclosed between the terminal branches; origin of the fourth superior subcostal nervule less than half way from the origin of the third to the tip of the wing. The whole costal border, as far as the subcostal nervule and the outer border, more broadly than the width of an interspace, margined with black; inner border similarly margined as far as the submedian nervule; a large, triangular, black patch depends from the costal margin half way between the extremity of the cell and the apex of the wing, and sends downward as far as the upper median nervule a black stripe, which strikes the outer black border in the middle of the lower median interspace; there is also a small, black spot next the under edge of the subcostal nervule at about the middle of the outer half of the cell, sometimes white pupilled; there is a submarginal row of moderate sized, quadrate, occasionally lunulate, white spots, one in each interspace, the lowermost double, distant from the outer border by a little less than the width of an interspace; occasionally, midway between these and the margin a few scattered white scales; the base of the upper of the broad subcostal interspaces is filled with a patch of white and the interspace below has sometimes a dot at the extreme base; the lower two subcostal interspaces, and sometimes the one next to them, have roundish, white spots in the interior half of the subapical black patch, the edges of which are powdery; the limit of the discoidal cell is sometimes indicated by an inconspicuous line of brown scales; fringe black, suddenly and rather broadly interrupted with white in the interspaces. Outer margin of the *hind-wings* alike in both sexes, strongly and regularly rounded, but not so strongly as in the other species, thus resembling *Anosia* which it mimics in color; the border is but faintly crenulate. First median nervule originating at the same distance from the base as the last subcostal nervule. Outer border margined with black as broadly as on the fore wings, and, as there, with a submarginal row of white spots or lunules, and occasionally a second faint row of scattered scales; a narrow, somewhat arcuate, median, black stripe, sometimes reduced to a faint line on one or two interspaces, sometimes broader than the black edged veins, crosses the wing from the middle of the outer two-thirds of the costal border, where it is broadest, to the submedian vein, just within the black bordering of the outer margin; fringe as on fore wings.

Beneath resembling the upper surface, but paler and with the same black markings; the white spots also are all repeated, their edges often varied with bluish white scales, the submarginal rows more distinctly lunulate and the outer series nearly as distinct as the inner; the costal and subcostal veins of *fore-wings*, between the subapical black spot and the outer limit of the cell, more or less washed with white, as occasionally happens above; and the median stripe of the *hind wings* is sometimes partly bordered

interiorly with indistinct white spots, themselves margined interiorly with black; there is also occasionally a faint, whitish spot at the divarication of the costal and subcostal nervures of the hind wings; fringe of both wings as above.

Abdomen blackish, annulated beneath, at the segment tips, with white and furnished with a narrow, lateral line of white, broadening on the last segment. Male appendages (33: 11, 12): upper organ; hook straight on its basal narrowing half, beyond curving considerably and increasing slightly in height half way to the tip, then narrowing rapidly by the sloping of the upper edge only, the apex more attenuated than in the other species. Clasps differing much more from the other species than these from each other, being two and a half times longer than broad, from beyond the inferior prominence tapering rapidly and pretty regularly with broadly sinuous margins, the apex bearing a few, small, unequal teeth, one of them prolonged into a long, slender, slightly tapering, pointed process, curving very strongly downward and slightly inward, half as long as the breadth of the clasp; interior finger very stout and tapering on the basal half, directed upward and backward; beyond free, nearly equal, slightly curved, directed upward, beset with minute prickles, rounded at the tip and extending by half its length above the clasp, which has but little expansion of the upper edge to guard it.

Measurements in millimetres. Length of tongue 10-12.5	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	31.	35.5	36.5	33.	39.5	39.5
antennae.....	15.	16.5	16.5	15.	16.	16.
hind tibiae and tarsi...	8.25	8.5	8.75	8.25	9.25	9.25
fore tibiae and tarsi ..	3.25	3.5	3.75	3.	4.	4.

Described from 7♂ 5♀.

Suffused variety. B. A. PSEUDODORIPPUS (ab. *pseudodorippus* Streck. Cat. Amer. Macrolep., 143; Can. ent., iv: 216). In the collection of Mr. T. L. Mead, now owned by Dr. W. J. Holland, is a suffused specimen of this butterfly, which lacks all markings above excepting the dark veins and borders, and, on the fore wings, a slight indication of the preapical triangle, blurred and diminished in size; the only white marks are on the outer border, in the lowest subcostal interspace and below it, where on the fore wings they are large and blurred; and on the hind wings blurred also, but of the natural size. The under surface of the wings is similar to the upper, but the apex of the fore wings is paler and there is a faint indication of the white spots which normally border the transverse black stripe of the hind wings; on the same wings, the white markings of the margins are peculiar, for they border interiorly the whole of the black margin; on the fore wings they border nearly the whole margin in the same way and form rather large powdery lunules; the outer line of white of the normal wing is faintly marked as a nearly continuous line. It was taken in the Catskills.

Mr. Strecker says he has an example from Holyoke, Mass. (Chase) "which differs from the above in the total obsolescence of all white lunules in margins of both surfaces; ... the mesial line of secondaries is very faintly visible. . . It was a male."

For notice of hybrids between this species and the others, see them.

Egg (64:13). Surface smooth, covered with deep cells, the floor of which is concave, the walls very thin and elevated, forming quite regular hexagons, the vertical sides of which are usually longer than the others, the longitudinal diameter of one of the cells in the middle of the sides being .15 mm., and the transverse diameter, .12 mm.; the cells are smaller at the very bottom of the egg; from each angle of the walls projects an erect, delicate, tapering filament or spine, .1 mm. long, .067 mm. broad at base, tapering, truncate at tip; this amature covers every part of the exposed portion of the egg, excepting the micropyle, to such a degree that it would seem as if it would interfere below with the proper attachment of the egg. Micropyle (67:9) .127 mm. in diameter; and the irregular cells composing it from .0128 to .017 mm. in diameter, the smaller cells being nearest the centre. Color when laid of a deep green, exactly that of the upper surface of the leaf on which it is placed; afterwards it becomes translucent; spines pellucid; height (not including spines), .88 mm.; breadth, 1.04 mm.

Caterpillar. *First stage* (70:7). Head (78:31) regular and smooth, yellowish brown, dusted with brown, with a few scattered luteous, scarcely elevated papillae, each giving rise to a short, yellowish hair; ocelli black; most of mouth parts castaneous; labrum and basal joint of antennae whitish; rest of antennae fuscous. Body slightly lighter than the head, of a dull olivaceous tint, more or less infuscated, sometimes heavily blotched with black laterally, paler or more yellowish on the fifth, and darker or duskier on the second and third abdominal segments, sometimes also on the thoracic and sixth and seventh abdominal segments; the terminal segment pale; beneath the body is purplish brown, the legs and prolegs concolorous, the claws of the former piceous; surface of body decidedly but very delicately shagreened, the larger papillae (86:58) tipped with fuscous. Length of body, 2.75-3.75 mm.; breadth of same, .5-.6 mm.; of head, .7 mm.

Second stage. Head (78:32) irregular and tuberculate, mostly dark brown, including the tubercles, but with a broad frontal and lateral stripe pale or white; mouth parts blackish. Body with more contrasted colors than before, mostly blackish both above and below, excepting the dorsal surfaces of the fifth and posterior part of fourth abdominal segments, which are pale luteous, and excepting also the compound tubercles, which are dark olivaceous brown; the innumerable and now irregular papillae (86:59), whether of body or tubercles, are either of the latter color or luteous or some shade between the two, and the short hairs emitted by them are fuscous; on the fifth abdominal segment the wartlets are all luteous. The legs and prolegs are of the color of the body and the spiracles are piceous with a fuscous aureola. Length of body, 5 mm.; breadth of same, .7 mm.; of head, .8 mm.

In this stage the body is completely roughened with closely set tubercles, particularly before it has extended the integuments of the body by feeding.

Third stage. Head (78:33) blackish fuscous, striped with paler colors as in the previous stage, the tubercles brownish yellow; mouth parts black. Body blackish fuscous spotted and streaked with velvety black; on the thoracic segments and the sides of the anterior abdominal segments indistinctly tinged with dirty brownish yellow; more distinctly in a streak upon the sides of the other abdominal segments, broadening posteriorly on the seventh to the ninth segments. The posterior half of the fourth abdominal segment and the whole of the fifth segment above the spiracles, excepting a small patch in the lower posterior corner of the latter, whitish. Principal tubercles black, beset with brownish yellow warts; other tubercles brownish yellow or whitish, the latter occurring on the paler parts. A delicate, pale, ventral line along the whole body; spiracles black, surrounded with pale yellow; legs and prolegs black. Length, 7.75 mm.; breadth of body, 1.25 mm.; breadth of head, 1.35 mm.; length of thoracic tubercles, 1 mm.; length of tubercles of ninth abdominal segment, .75 mm.

Fourth stage (78:34). In this stage it has assumed all the general appearance of the adult, both in coloration and in the general proportion of the humps and tubercles to the body, but they are all of a smaller size, and the larger tubercles of a slightly different shape. The body is now not nearly so closely beset with tubercles as before. Length of body, 20 mm.; breadth, 3.75 mm.; length of tubercle of second thoracic segment, 3 mm.

Last stage (74:19, 22, 24). Head (78:35) reddish or purplish brown, each side with two longitudinal yellowish brown streaks uniting in a curve just above the base of the antennae; tubercles mostly reddish brown, often a little darker than the head, those of the hinder edge pale; the large tubercle of summit reddish brown, surrounded by paler ones; it is higher than broad, the sides not swollen, though often appearing so by the crowded wartlets, apparently larger at summit than at base, crowned with pretty large, conical, pointed wartlets, which materially increase in size, and in front of them two circular, smooth warts larger than the others; base of antennae pale, second joint infuscated, third pale yellowish brown; ocelli black; mandibles blackish; other mouth parts dusky or reddish fuscous. Thoracic segments dull, dirty, brownish yellow or clayey brown, obscured slightly and mottled with fuscous, and, especially the first segment, with small, blackish dashes; rest of the body very dark brownish olivaceous or dark reddish, tinged in some places with brownish yellow, occasionally running

into black; upon the fifth abdominal segment and the posterior part of the fourth, extending also forward and backward in broad streaks over a part of the dorsum of the third and sixth abdominal segments, is a large, saddle-shaped spot of a dirty, dull cream color, generally tinged slightly with greenish; the mammiform elevation of the second abdominal segment dull, olivaceous brown; just above and behind the spiracles of the third, fourth and sixth abdominal segments there is a short, oblique patch of velvety black; the infrastigmatal fold of the abdominal segments is edged above with white, passing upward a little behind each spiracle, and on the ninth segment broadening into a spot; elongated, tuberculated spine of the second thoracic segment dark mahogany brown, some of the tubercles upon it, especially the apical ones, tipped with pale; it is pretty abundantly supplied with long and large, conical, curving tubercles, higher than broad; the minute warts of the body mostly dull, steel blue, but also yellowish and purplish; spiracles slate color, edged narrowly with black; legs blackish at base, beyond yellowish brown or testaceous; prolegs dirty olivaceous or yellowish brown.

Some specimens taken on willow (those forming the basis of the above description were, I believe, all taken on poplar, though fed in part on willow after capture) were delicate, olivaceous green almost throughout, with scarcely any dark, olivaceous tints and none very dark; the laterodorsal tubercles of the second abdominal segment were dull, brownish yellow; the infrastigmatal band and the saddle as in the others; but the head was pale olivaceous green. Length of body, 25-30 mm.; breadth of body, 4-5 mm.; of head, 7 mm.; length of thoracic tubercles, 4-4.5 mm.; of terminal abdominal tubercles, 1-1.25 mm.

Chrysalis (83: 18-20). Head, wings and the appendages in front varying from blackish green to very dark yellowish brown, the legs, tongue and antennae with a greenish tinge; thorax varying from brownish salmon much mottled with plumbeous to inky olivaceous tinged with dull yellowish; the mesothorax is darker along the median line and on the middle of either side is a black dot; next the wings on the sides of the first to the fourth abdominal segments and of the anterior part of the fifth, and sometimes of the metathorax, salmon nacreous, often a little obscure; dorsal tubercle of the second segment, together with a broad streak adjoining the whole of the nacreous band beyond the anterior edge of the tubercle, blackish brown; rest of the abdomen whitish or very pale salmon colored, beclouded more or less with fuscous (or with a mottling of black and white made up in great part of interlacing streaks, the black predominating) in dorsal, lateral and broad subventral bands, the dorsal band often narrow and deeper in tint, the subventral closely approximated to its neighbor; eighth and succeeding segments blackish brown, often tinged with yellowish, and emitting little tongues of the same color upon the seventh segment, fading into the longitudinal bands. Spiracles of the color of the body with black lips. Length, No. 1, 24.5; No. 2, 17.75; No. 3, 22; breadth near tip of wings, No. 1, 8.5; at head, No. 1, 3; No. 2, 2.5; No. 3, 2.6; height at abdominal tubercle, No. 1, 10.25; No. 2, 7.5; No. 3, 8.5; at thorax, No. 1, 7.5; No. 2, 5.5; No. 3, 6.25; height of abdominal tubercle, No. 1, 2.5; No. 2, 1.75; No. 3, 2—all in mm.

Distribution (19: 2). This species is found over nearly the whole of the United States as far west as the Sierra Nevada, and has been found sparingly even to the Pacific coast near our northern boundaries (British Columbia and Oregon, — Edwards). It is rare in the extreme west, and I have not noticed its occurrence in Colorado, Arizona or New Mexico, though it has been found in southwestern Wyoming by Osten Sacken, in central Utah by Putnam, and near Truckee, Nevada by McGlashan. To the south it appears to reach the Gulf of Mexico, though how far it penetrates the peninsular of Florida, where an allied form exists, I do not

know. The northernmost localities from which it has been reported are Crow's Nest and Calgary, N. W. T. (Geddes) and Moose, Hudson Bay, one specimen (Weir). Edwards says it reaches latitude 52° . Eastward it has been taken at Ottawa (Billings, Fletcher), Montreal (Caulfield), on the St. Lawrence 135 miles above Quebec (Bowles) and in Nova Scotia (Jones).

Within New England it occurs abundantly in the south, more sparingly in the north, although found in the very heart of the White Mountains. The northernmost points from which specimens are recorded are Mount Desert Island (Scudder), Orono (Fernald), Waterville (Hamlin), Hallo-well (Miss Wadsworth) and Norway, Me. (Smith); Franconia, Wing Road and the Glen, White Mountains, N. H. (Morrison, Scudder), Sudbury (Scudder) and Stowe, Vt. (Miss Soule).

Haunts. The butterfly is found in open country in fields and meadows, especially in low grounds, and hovers fondly over blossoms of the golden rod (*Solidago*). In Iowa, Mr. Allen found it in open groves.

Oviposition. The female always chooses the terminal leaves of a twig for the deposit of her eggs, and even the tip of the leaf. They are usually laid on the upper surface, and it is very rare to find more than a single egg on a leaf, though Riley records an instance of three together and says that he has found them on both sides of the tip of the leaf, base to base; I have never seen such a case, and with hardly an exception have found them laid singly, and in nearly nine cases out of ten, on the upper side at the very extremity; out of twenty-two collected in one day, five were found on the lower, the others on the upper surface. Miss Soule records (*Psyche* v: 14), a similar case of more than one egg to a leaf: "One leaf had four eggs; one at the tip, two on one edge near the tip, and one on the other edge near the tip. Another leaf had two; one on the tip, the other near it. The third leaf had three irregularly placed near the tip." All these, with the possible exception of one of the first four, Miss Soule saw laid. Afterwards four eggs were found on a willow leaf, two on each side of the tip. The butterfly was exceptionally abundant.

Specimens have been received by me from Misses Guild and Murtfeldt. The duration of the egg varies from four to eight days. Of two laid within five minutes of each other on August 4th at noon, one hatched at nine o'clock on the 8th, the other in the night of the 10th-11th. All of the eggs seen laid by Miss Soule, hatched within twenty-four hours of each other.

Food plant. *Salicaceae* form the favorite food of this caterpillar. Mr. Lintner writes that he has taken it on six or eight species of *Salix*; among the plants of this family upon which it lives are golden willow, black willow (*S. nigra* Marsh.), the long-beaked willow (*S. livida*, var. *occidentalis*), and silky leaved willow (*S. sericea* Marsh.). Of *Populus*,

the balm of gilead (*P. balsamifera*, L., var. *caudicans* Ait.), aspen (*P. tremuloides* Michx.), cotton wood (*P. monilifera* Ait.), and Lombardy poplar (*P. dilatata* Ait.). *Populus* seems to have a greater attraction than *Salix*, though by no means, it appears to me, to such an extent as Mr. Edwards finds in his experience. He writes:

At Coalburgh, the larvae . . . feed on willow, and no aspen grows in this part of the state [W. Va.]. In the Catskills, both willows and aspens abound, and there this species prefers to feed on the latter. I have often found their cases on young aspens late in the fall, but never on willow, though willow would be used if there was no choice. In 1876, I brought several small aspens to Coalburgh . . . and since that time I find many larvae . . . feeding on the leaves; but on the willows near by, on which I had been accustomed to find them, I rarely have met one. Here was a case where perhaps for hundreds of generations neither caterpillar nor butterfly could have seen an aspen, but the moment one was produced, the butterfly knew what would suit the caterpillar best, and deserted the willow" (Butt, N. A., ii.).

Boisduval and LeConte state that it is found on several species of *Prunus*, which is partially verified by Walsh, who say it feeds occasionally on plum, and Saunders adds cherry to the list. Mr. Lintner has also taken it on apple, and Abbot figures it on *Chrysobalanus oblongifolius* Michx., a rosaceous shrub of the pine barrens of Georgia. Kirtland even asserts that it is found on several species of oak and specifies *Q. rubra* L. Possibly the close resemblance between the different caterpillars of this genus may have misled some of these observers, especially in the case of oak. Riley states that specimens transferred from golden to black willow become much darker in color.

Habits of the caterpillar. On hatching, the caterpillar eats its way out of one side of the egg leaving the summit intact, but, under natural conditions, before attacking the leaf devours the shell to the very base. It now eats first the apical leaves (81:7), and then those next in order, omitting none in its passage down the stem, so that, as Lintner says, its position may be "at once revealed by the twig upon which it had fed . . . [being] entirely defoliated from its tip about eighteen inches downward, leaving only the footstalks remaining." It is solitary in its habits, although Mr. Lintner has found as many as five specimens on one small bush of *P. tremuloides*, and I once discovered fourteen eggs on one poplar. It moves about, particularly in early life, with a spasmodic motion and when disturbed, snaps its head upward repeatedly.

I once rested a leaf, on which a larva had just changed its skin for the first time, upon another in such a way that the eaten tip of the first just touched the last; the caterpillar which was eating its old skin with its tail toward the tip of the leaf, seemed at once to become aware of this and showed unmistakable signs of temper, lashing its head to one side and the other, dashing it while doing so against the leaf and finally arching its body and remaining immovable as if moody. It was a long while before it would resume its semi-cannibalistic feast.

In the same way when touched by another caterpillar it goes into a fury of rage, throwing the whole front half of its body violently to one side and the other and then causing the head to tremble vertically. If two, walking toward each other, meet and touch, the effect is ludicrous in the extreme, as they stand and swing their heads about, often striking each other violently in the operation. This is done as soon at least as after the first moult. Later in life it manifests its displeasure by moving its head in a circle around the leaf on which it rests, accompanying the movement by little spasmodic recoiling starts, making the leaf tremble.

Under natural circumstances, the caterpillar appears to feed almost entirely by night, for during the day one almost invariably finds it taking its siesta, while shortly after dark it is usually found either feeding or moving toward its feeding place; but in confinement it will feed quite as much by day as by night. It never remains upon its feeding ground when its appetite is satiated, but retires either to the untouched midrib of the leaf where the sides have been eaten away (81:8) or, when larger, to a twig; in either case it stops when it has reached its favorite spot and rests immovable, heading away from its food; appetite returning, it wheels about, hurries to its old feeding spot, and its meal finished, retires again to its accustomed station for a new siesta.

As the first tolerably full account of the hibernating habits of this caterpillar were given by Riley, I copy the account of their habits as given in his third Missouri Report, an account based on an article on Imitative Butterflies, by Messrs. Walsh and Riley ("the greater part of it written by Mr. Walsh"), which had appeared earlier.

The larvae of the autumnal brood when about one-fourth or one-third grown, build for themselves curious little houses, in which they pass the winter. First and foremost—with wise forethought, and being well aware through its natural instincts, that the leaf which it has selected for its house will fall to the ground when the cold weather sets in, unless it takes measures to prevent this—the larva fastens the stem of the leaf with silken cables securely to the twig from which it grows. It then gnaws off the blade of the leaf at its tip end, leaving little else but the midrib. Finally it rolls the remaining part of the blade of the leaf into a cylinder, sewing the edges together with silk. The basal portion of the cylinder is of course tapered to a point, as the edges of the leaf are merely drawn together, not overlapped; and invariably the lower side of the leaf forms the outside of the house, so as to have its projecting midrib out of the way of the larva, as it reposes snugly in the inside. The whole when finished has somewhat the appearance of the leaf of a miniature pitcher plant (*Sarracenia*), its length being .50-.65 inch., and its diameter .11-.14 inch. . . . The blade on the tip piece is sometimes gnawed off right down to the rib; at others it is left almost as broad as the tube. Sometimes it is bent over the orifice; at others not. They are also much more irregular and ungainly when made from broad leaves such as those of the silver poplar, than when made from the more narrow leaves of the willow. These autumnal larvae have also another peculiar habit not heretofore recorded, and which was first pointed out to me by Mr. J. A. Lintner, of Albany, N. Y. They exhibit a tendency to build from the time they are born, and will always eat the leaves from the side, gnawing large holes and cutting along the sides of the midrib. They commence at the tip and as they work downwards toward

the base, they collect the debris into a little bunch, which they fasten with silk to the midrib. When the hibernaculum is finished the seam is perfectly smooth and the whole inside is lined with silk. The larva, after completing its work, composes itself for the winter, with the tail towards the orifice. Here it remains till the catkins are in bloom the next spring, when it retreats from its house and commences feeding. Not the least wonderful part of the phenomenon is, that it is only the autumnal brood of larvae that form pitcher-like houses to live in during the inclement season of the year, the summer brood having no occasion to shelter themselves from the cold.

I am indebted to Miss Guild and to Messrs. Lintner, Sanborn and Trouvelot for many specimens of this larva, and to Messrs. Emery, Mark, Shute, Smith and Trouvelot for chrysalids.

Life history. In New England, this is at least a double brooded insect, though it is more than likely that it is triple brooded in the southern stations and probable that a third supplementary brood will be found everywhere. It starts the year in its larval hibernaculum as a caterpillar ordinarily in its second stage, but not at all infrequently in its first, and rarely in its third stage. To escape from its narrow winter quarters it must retreat backwards, and when it does this it is to find only the bursting catkins, and as yet no leaves of its food plant; upon these it breaks its long fast, and even sometimes attains nearly half its growth, but in May becomes full fed upon the tender leaves. The butterflies appear early in June, usually by the 5th or 6th, in the latitude of Boston, the earliest date recorded being May 31, when Mr. Lintner has taken specimens near Albany, N. Y. I have also found the larva nearly full grown at New Britain, Conn., on May 15. But they rarely become abundant before the middle of June, and continue to emerge from the chrysalis until the end of the month. Pairing takes place at once (Mr. Lintner records a case June 7), and eggs are laid in about a fortnight after the first appearance of butterflies, the earliest known to me being indicated by recently hatched caterpillars in the first stage as well as eggs found June 26, when the butterflies had been flying at that season about three weeks. In the north they ordinarily appear a week or ten days later than about Boston, the earliest dates known to me being June 9, at Hallowell, Me. (Miss Wadsworth), and June 11, at Wing Road, N. H. (Scudder), and I have also found badly battered females at Franconia, N. H., on June 27, which must have been out a fortnight. It is therefore a little earlier than *B. arthemis*, having apparently a little the start of it in the earlier provender provided by nature for the use of the hibernating caterpillars. Eggs are certainly laid in June, for I have found caterpillars in their first stage during the last week of June at Plymouth, N. H.

There is no little difference, apparently, in the rapidity with which the transformations are made, the eggs alone varying from four to eight days (ordinarily about six and one-half), but although the caterpillar is sluggish and by no means a gluttonous beast (as many are), the transformations

(speaking in this paragraph of the latitude of Boston only), generally take just about one month at this season of the year, and the second brood of butterflies makes its appearance in Massachusetts, after about ten (seven to ten) days in chrysalis* by about the middle of July—sometimes as early as the 10th of the month, flying, therefore, for a fortnight or more in company with many individuals of the first brood, and continuing to emerge from the chrysalis during the whole of July, and certainly a part of August. The first and second brood commingling, and the females of the second being ready to lay their eggs by the time the females of the first have closed their labors, the butterfly may be found in almost or quite every stage throughout July and August. This renders the precise appearance of a third brood uncertain; that there is such a brood, the sight of plenty of fresh females laying their first eggs (as proved by their abundance in the abdomen) at the very end of August and early in September, abundantly shows; for if the third brood, undergoing its transformations in the hottest season, follows only as rapidly on the second, as the second on the first, the first butterflies of this brood should appear early in August and be ready to lay eggs shortly after the middle of the month; good specimens fit for the cabinet may still be obtained in the second week in September, and egg-laying continues at least into the third week and probably throughout the month. The females will sometimes be found flying with only tattered remnants of wings (61: 25).

In the White Mountain district, the second brood is not usually seen until near the end of July; and thereafter, as in the south, fresh specimens may be found the rest of the season, or until at least the middle of August. The earliest butterflies of this brood may in some years be able to lay eggs by the first week in August, and a third brood, or a fragment of it, a supplementary brood, appear early in September; whether there would then be time for the development of the eggs within and without the body of the parent, and the growth of the larva past its first moult (the latter only a couple of days), may perhaps be questioned, but in favorable seasons and in protected localities in the lower levels it seems in no way impossible. Butterflies may be found throughout September, including, I believe, a certain number of fresh specimens, though my notes are not sufficiently explicit on this point. I have found plenty of eggs and caterpillars in their earliest stages at Plymouth on September 7.

In the south the number of broods must be greater, but our data are very meagre; they fly as early as the latter half of March, and become numerous early in April about Appalachicola (Chapman). They are found again in the latter half of May and early in June, and there must be at least three broods after that. Abbot raised one from chrysalis on

*Mr. Billings, of Ottawa, says he has had specimens in chrysalis for only five days, but as he records equally brief periods for chrys-

alids of other butterflies, there may have been something peculiar about his breeding cage. See also under *Aglaia milberti*.

August 7. Its mode of passing the winter, however, is the same in Missouri and in West Virginia as in the north; only Mr. Edwards says that they always reach their second and sometimes their third stage before hibernation, and he has found them exposed as late as October 12. It is a curious thing that we find in the caterpillars of the first brood no tendency whatever to construct hibernacula; here we have an instinct inherited by alternate generations; or only when the nightly chills or the desiccating food indicate the coming of an unfriendly season.

It is hardly probable that the butterfly ever hibernates; but Mr. Lintner records one butterfly as seen on May 8 at Schoharie, New York. If *Anosia plexippus* were not mistaken for this species, as Mr. Lintner himself thinks possible, so early an apparition would surely indicate that the insect had wintered either in the chrysalis or imago state.

Habits, flight, etc. This butterfly is very fond of the juices of apples drying in the sun and of over-ripe fruit. Jack has noticed it alighting on leaves curled by plant lice and drinking the sweets exuding from the caruncles of the Aphides.

The flight of this butterfly is rather leisurely and sailing; it moves irregularly from place to place, occasionally returning to the same spots.

When at rest, the body is raised at an angle of from 30° to 35° , the wings are closely compressed, the tip of the fore wings placed above the middle of the abdomen and so concealed by the hinder pair as to leave uncovered only six of the submarginal row of spots. The antennae are nearly straight, having an almost imperceptible bend in the middle by which the tips are slightly approximated; when the insect is on a horizontal plane, they are raised at an angle of about 15° with the body and spread about 70° ; but when the insect is in a perpendicular position, the head downward, the divarication is only about 45° , and the antennal tips about 13 mm. apart.

Mimicry. There exists among North American butterflies no more complete mimicry than is shown by the imago of this species for that of *Anosia*. How close it is will appear at once by comparing the figures of the two upon our first plate; and how far it has departed from its ancestral pattern and colors may be inferred on a comparison of figure 5 with the figures of the other forms of the genus on Plate 2, figures 5, 8 and 9. The ground tint, which is almost identical in the other forms of *Basilarchia*, has changed completely from a blue black to the deep orange, characteristic of *Anosia*; this has apparently been brought about by a complete suffusion (and perfect transference to the upper surface, as well) of the orange spots which are found only at the base and near the outer margin of the other species, and which are usually wholly distinct, or confluent only near the tip of the fore wings. In the pattern of the markings we find the nearest approach to the form *proserpina*, which, as a hybrid of the other two New England species, may possibly indicate more clearly than either of them the

form from which both were derived; at least the course of the transverse stripe of our present species, which though black, includes some white spots in the fore wing, and is interiorly margined with white on the under surface of the hind wings, more nearly accords with that of *proserpina* than with either of its parent species; this stripe on the hind wing finds no counterpart in *Anosia*; but on the fore wing, by its expansion toward the costal margin and its enclosure there of some small white spots, heightens the resemblance to the apex of the wing in *Anosia*, further aided by the paleness of the marginal lunules in all the wings. The butterfly is found over very nearly the same area as *Anosia*, and where the darker mahogany-colored and also "protected" Euploeid species of *Tasitia* comes in, this butterfly takes on a mahogany hue,* which is still more marked in the allied and also mimetic species, *B. eros*, which supplants it further south where *Tasitia berenice* has fuller sway.

Experiments and endurance. A chrysalis of this species, brought to me pierced through with a large insect pin when about four days old, gave out the butterfly as usual (or would have done so if it could) as if entirely unaffected by the pin. The head case was thrown off in the usual manner, and one fore wing was extricated and fully developed.

Some experiments on the action of this butterfly when the antennae are cut off near the base, or the eyes blinded by a layer of thick pigment, or both, will be found recorded by Mr. L. Trouvelot in the *American naturalist*, xi: 193-4.

Mr. Edwards has placed on record some observations on the result of submitting the chrysalids to extreme cold (*Psyche*, iii: 174). He found that if subjected to a temperature of 32° they were killed. In another experiment one was placed when six hours old in a temperature of 40° for fourteen days; a second when twelve hours old in the same temperature for ten days. The first produced a male in seven days, the second a female in six days after removal from the ice. Both were "alike in color above and below; above dark, resembling southern *Danais archippus*. In the male the black mesial band on hind wings is wider than usual . . . but in the female this band is extraordinary, nearly three times as wide as usual. . . . Beneath, in both, the hind wing is very light, a fawn color, with no fulvous tint, quite unlike any . . . western or southern example, though resembling Catskill examples, except that these have a tint of fulvous."

Enemies. This butterfly is a martyr to at least half a dozen hymenopterous parasites; the caterpillar of the summer brood is attacked in great numbers by an unknown parasite (the specimens are lost) which afterwards emerge from the chrysalis, the chrysalis itself remaining intact through the autumn and winter; indeed it is not until late in the following spring (before the summer brood of caterpillars appears, however) that the im-

*This form (*floridensis*), is also found in the Mississippi Valley far to the north, and has

even been reported from Dakota (Heart River' Allen), far beyond the limits of the *Tasitia*.

prisoned Hymenoptera make their escape. One June 25 I was examining a wintered chrysalis given me by Mr. L. Trouvelot, when it suddenly began to swarm with these little parasites. Instantly upon emerging from little holes which they had bitten out near the tips of the wings, they began to pair, the males awaiting the females at the edge of the opening. They ran rapidly upon and about the chrysalis and made short, hopping flights of a little more than a centimetre in distance. All but two specimens were secured and I was surprised to find the proportion of males to females less than one to six, the total number being 17 males and 108 females. All had emerged within half an hour of the appearance of the pioneer.

The wintering caterpillar is also attacked by *Apanteles limenitidis*, a larger hymenopterous parasite, which stings a single larva while very young, emerging from its host while it is in the second stage and spinning its cocoon beside the larva upon the silk which had afforded it a foothold. One may sometimes find these cocoons on the eaten leaves just before the time for the caterpillar to seek winter quarters. *Limmeria limenitidis* (88:5) and *Ichneumon caliginosus*, also among the larger forms, are further enemies of the caterpillar, and Riley states that he has often noticed the eggs of one of the Tachinid flies "fastened transversely on the back of the neck of the larva," though none has ever been reared. Nor is this all; the egg also has its perils. Miss Guild discovered late in July one or two specimens of a leaden hue, which upon examination proved to be empty, the parasites having escaped through an almost imperceptible hole in the bottom of the egg; within was a sort of hardened, gummy nidus of eaked yolk, covered over with a thin layer of spun silk, but no pellicles of chrysalids could be seen. Mr. Riley has since been more fortunate, having obtained a parasite and described it under the name of *Trichogramma minutum*. Out of about two hundred eggs of this butterfly obtained in a single spot fully one-half were parasitized, from four to six flies escaping from each egg. I have since found others late in June similarly attacked, which belong to a second species of the same genus, *T. minutissimum*. I have also more than once found the base of an eaten egg, on an untouched leaf, showing the presence probably of spiders which had snatched away the little caterpillar before its second meal.

Desiderata. It is essential to note the comparative abundance or absence of this insect in every possible northern locality in order to determine its exact limit; to record also the exact time at which the caterpillar leaves its hibernaculum on each kind of tree; how many times the larva moults before constructing its winter residence and whether the stage is invariably the same; whether the summer caterpillars ever hibernate after the manner of *Nymphalis*; how commonly it winters in the imago state and whether such hibernation is common to both sexes; and finally in what features the flight of this butterfly differs from that of its congeners.

LIST OF ILLUSTRATIONS.—*BASILARCHIA ARCHIPPUS*.

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| <p><i>Egg.</i></p> <p>Pl. 64, fig. 13. Colored.</p> <p>67: 9. Micropyle.</p> <p><i>Caterpillar.</i></p> <p>Pl. 70, fig. 7. Caterpillar at birth.</p> <p>74: 19, 24. Full grown caterpillars.</p> <p>22. Outline showing attitude.</p> <p>78: 31-35. Front view of head in stages I-v.</p> <p>81: 7, 8. Leaves as eaten by the young caterpillar.</p> <p>86: 58. Dermal appendage of body, first stage.</p> <p>59. Dermal appendage of body, second stage.</p> | <p><i>Chrysalis.</i></p> <p>Pl. 83, fig. 18. Outline, dorsal view.</p> <p>19. Outline, side view.</p> <p>20. Colored, side view.</p> <p><i>Imago.</i></p> <p>Pl. 1, fig. 5. Male, both surfaces.</p> <p>11: 4. Both surfaces.</p> <p>33: 11, 12. Male abdominal appendages.</p> <p>61: 25. Outline of wings of a battered specimen.</p> <p>28. Papilla of tongue.</p> <p><i>General.</i></p> <p>Pl. 19, fig. 2. Distribution in North America.</p> <p>88: 5. <i>Limneria limenitidis</i>, a parasite.</p> |
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BASILARCHIA ASTYANAX.—The red spotted purple.

[Red spotted purple (Gosse); red spotted purple butterfly (Packard); orange spotted butterfly (Ross); blue-banded butterfly (Maynard); Ephestion butterfly (Harris); Ursula butterfly (Saunders); wildcherry limenite; gooseberry butterfly (Emmons).]

Papilio astyanax Fabr., Syst. entom., 447 (1775).

Limenitis astyanax Butl., Catal. Fabr. Lep., 60 (1869).

Basilarchia astyanax Seudd., Syst. rev. Amer. butt., 8 (1871).

Papilio ephestion Stoll, Suppl. Cram., Pap. exot., 121, pl. 25, figs. 1, 1a (1791).

Najas turbida ephestion Hübn., Samml. exot. schmett., i, Lep. i, P.p. i, Nymph. v, Najades C, turbidae b, figs. 1-2 (1806-19).

Nymphalis ephestion God., Encycl. méth., ix: 17, 42-43, 804 (1819);—Harr., Ins. inj. veg., 3d ed., 283 (1862).

Limenitis ephestion Harr., Hitehe. Rep., 590 (1833).

Callianira ephestiaena Hübn., Verz. schmett., 38 (1816).

Papilio ursula Fabr., Entom. syst., iii: 82-83 (1793);—Abb., Draw. ins. Ga. Brit. mus.,

vi: 35, fig. 16; 36, fig. 17; xvi: 23, tab. 3;—Smith-Abb., Lep. ins. Ga., i: 19-20, pl. 10 (1797).

Nymphalis ursula God., Encycl. méth., ix: 337, 390-381 (1819);—Boisd.-LeC., Léop. Amér. sept., 199-201, pl. 53, figs. 1-4 (1833);—Morr., Syn. Lep. N. Amer., 64-65 (1862).

Limenitis ursula Westw.-Hew., Gen. diurn. Lep., ii: 276 (1850);—Emm., Agric. N. York, v: 203, pl. 33, figs. 1-2 (1854);—Harr., Entom. corresp., 276-277, pl. 4, fig. 15 (1869);—Ril., Can. ent., iii: 52-53, fig. 24, 117-118 (1871);—Mead, Can. ent., iv: 216-217 (1872);—French, Rep. ins. Ill., vii: 154 (1878); Butt. east. U. S., 206-207, fig. 58 (1886);—Middl., Rep. ins. Ill., x: 87 (1881);—Coq., ibid., 162 (1881);—Saund., Ins. inj. fruit, 217-218, fig. 223 (1883);—Mayn., Butt. N. E., 9-10, pl. 1, figs. 10, 10a (1886).

Figured by Glover, Ill. N. A. Lep., pl. 33, fig. 8; pl. 91, fig. 22; pl. A, fig. 12, ined.

If I were thou, O butterfly,
And poised my purple wings to spy
The sweetest flowers that live and die,
I would not waste my strength on those,
As thou,—for summer hath a close,
And pausies bloom not in the snows.

BROWNING.—*Wisdom Unapplied.*

Imago (2: 8). Head blackish brown; on the posterior border, just behind the base of each antenna, a minute triangular white patch, the apex directed forward; eyes bordered posteriorly with white, rather broadly below, narrowing to a point above, commencing below just where the base of the tibia of the retracted fore legs strikes the eye, terminating above a little beneath the superior triangular spot. Antennae uniform blackish brown throughout, the minute terminal joint of the club dull orange luteous, the succeeding four or five joints more or less tinged with the same, especially beneath. Palpi blackish brown; a broad median line of white scales, narrowing above, lines the inner side to the very tip; the outer upper half of the basal joint is white, and a very

broad, conspicuous band of white scales, narrower on the terminal joint, runs along the outer anterior border of the two terminal joints, extending to the very tip; all of these white portions have black hairs scattered among them. Tongue black; papillae (61:33, 53) as long as the width of one maxilla, comparatively stout, about three times as long as broad, the apical filament nearly cylindrical, about half as long as width of papilla.

Thorax blackish brown above and below, sometimes, especially beneath, with an olivaceous tinge; on the sides beneath, next the base of all the wings, a minute white spot, situated between the origin of the costal and subcostal nervures; a short, slender, longitudinal, white streak next the insertion of the median. Middle and hind coxae with a very large patch of soft, pale, bluish gray hairs over dark brown ones; middle and hind trochanters white; under surface of femora with a few pale scales; fore tibiae and tarsi white anteriorly, blackish brown posteriorly; middle and hind tibiae and tarsi blackish brown, tarsi a little paler beneath; spines black; claws dull dark luteous, reddish at tip.

Wings above velvety indigo black, with a lustre varying from dark rich purplish blue to dark olive green, the apical third of fore wings—usually (♀) or to a less extent if at all (♂)—tinged with dull slate brown. *Fore wings* entirely resembling in form those of *B. arthemis*, but differing from those of *B. archippus* in their more curved costal and outer margin. Third superior subcostal nervule arising midway between the second and fourth superior branches; the fourth at nearly three-quarters the distance from the origin of the second to the tip of the wing. A submarginal row of hoary blue or greenish spots, one in each interspace, smaller and usually paler above, becoming transverse lunules below; midway between these and the border, usually more conspicuous on the lower than on the upper half of the wing, there is a powdering of similar scales, occasionally obsolete, in transverse streaks; following close upon the submarginal row, in the two lower subcostal and in the median interspaces, is a series of rusty or tawny, roundish spots, sometimes large and distinct, sometimes obsolete; at the origin of the fourth subcostal nervule there is a minute, sometimes obsolete white spot, and above and below it, in the adjoining interspaces, are large, triangular white patches, together forming a row parallel to that next the margin; on the costal border, about three-fifths the distance from the base, there is occasionally, especially in the female, a long powdery white dash, following the costal border, but not attaining the costal edge. In the lowest two interspaces, in almost direct continuation with the row of reddish spots, but a little further inward, is a transverse series of hoary blue or green patches, sometimes indicated by a slight touch in the interspace next succeeding, and sometimes continued as a narrow and ordinarily very faint band of similar spots, parallel to the outer border and connecting directly with the subapical row of white spots just mentioned; occasionally, especially in the female, a slender transverse streak of rusty scales marks the extremity of the cell. Fringe black and white in nearly equal alternate patches, the white rather more prominent, the black at the nervure tips, the white of the medio-submedian interspace divided by black. *Hind wings* wholly resembling those of *B. arthemis*, but differing from those of *B. archippus* in having the outer border pretty strongly crenulate, more strongly arched, and either slightly (♀) or pretty conspicuously (♂) produced at the upper median interspace. First median nervure originating farther from the base of the wing than the last subcostal nervule. A double submarginal row of large, broad, pale blue or pale green lunules, very distinctly separated by the nervures, and one row as distinctly from the other, the inner row a little the larger; following these is as broad a belt of velvety black, narrowing at each end, and especially below; then a belt, of variable width, of pale purplish blue, or pale olivaceous green spots, distinctly separated by the black nervures; usually they are squarish and as broad as long, sometimes reduced to mere transverse stripes, but sometimes, on the contrary, have their interior border inconspicuous or unrecognizable by the greater or less suffusion of the adjoining parts of the wing with the same color—to some extent almost to the base; occasionally they are marked along their exterior border with a row of small, rusty, roundish spots; area next the inner border dark slate gray; fringe as on the fore wings.

Beneath, the wings are dark lustrous purplish blue, generally tinged strongly in part with greenish, especially in the cell, obscured in places, and especially in the interspaces of the hind wings, with tints varying from dark olivaceous brown through dingy snuff color to obscure tawny or even dull orange, flecked with dark brown, most distinctly in the female; the nervures always blue black. *Fore wings*: The whitish streak near the middle of the costal margin of the upper surface is repeated beneath, and the apex of the wing from the middle of this to the middle of the central median nervule and extending as far as the submarginal markings is olivaceous slate brown, enlivened with a few tawny atoms. In the centre of the cell is a roundish, at the extremity of the cell a long, transverse, bright reddish, orange spot, broadly encircled with velvety black; on either side of the first, bordering the subcostal nervure, is a small delicate pale blue patch, the outer the smaller; there is a submarginal, double row of pale blue transverse stripes, a pair in each interspace, the inner row more curved and slightly paler, the outer slightly broken in the middle of each interspace; these are followed interiorly by a row of quadrate, pale, rusty orange spots in the median and most of the subcostal interspaces, corresponding to those sometimes appearing above; and these again, on the upper half of the wing, by some unequal whitish spots, corresponding again to those on the upper surface and often, as there, extending faintly on the lower interspaces; there is a streak of dull orange on the costal margin next the base of the wing; fringe as above. The *hind wings* have three little patches of scattered blue scales at the base of the wing, one enclosed in the curve of the precostal nervure, one at the divarication of the costal and subcostal nervures, and one at the base of the cell; costal margin at base broadly bordered with reddish orange; three large, roundish, bright reddish orange spots, bordered rather broadly with velvety black in the basal portion of the wing, viz.: one oblique oval spot at the base of the costo-subcostal interspace next the blue spot; one roundish, or transversely oval, slightly larger spot at the base of the cell just beyond the blue spot; and an oblique, transverse, quadrate spot in the cell, separated from the preceding by a considerable space, more or less filled with bluish or greenish scales. There is a double row of submarginal bluish spots next the outer border, similar to those of the fore wings, only of equal depth of tint; these are followed by a regular row of nearly equal, roundish or semicircular, orange spots, the lower one transverse, bordered very broadly below, to a less extent above, with velvety black; upon the upper black margin of these spots is seated a collection of somewhat scattered, rather pale blue or greenish blue scales with some intermingled blackish scales; fringe as on the upper surface.

Abdomen above blue black; on the sides the same, with a slender, median, white line; below the same also, the middle half of the segments edged posteriorly with white, narrowly in the female, broadly and sometimes coalescent in the male. Appendages of the male (33:15): upper organ; hook regularly and gently curved throughout, equal in height until the tip is reached, which tapers rapidly to a point and is excised beneath. Clasps very nearly three times as long as broad, beyond the prominence of the lower edge tapering rather rapidly and regularly to a somewhat broad, rounded apex, but with a prominent extension of the upper border a little before the middle of the free portion; this extension is twice as long as high, one-half as long as the breadth of the clasp; apex of clasp not one-third so broad as the base and with the apical portion of lower edge armed with six or eight small pointed spines; interior finger much as in *B. archippus* but not so roughly beset with prickles, a little pointed at the tip, and the extremity mostly hidden by the prominence of the upper edge of the clasp.

Measurements in millimeters.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 11.5						
Length of wings.....	35.	37.5	40.5	34.5	44.	48.
antennae	15.5	16.75	19.5	14.	18.75	19.5
hind tibiae and tarsi..	9.	10.	11.	8.25	10.75	12.
fore tibiae and tarsi..	3.5	3.5	4.25	3.75	4.75	5.75

Described from 24 ♂ 11 ♀.

Dimorphic forms, etc. For the form *proserpina*, see the next section, where it is discussed as a hybrid between this species and *B. arthemis*.

That hybrids between this species and *B. archippus* also occur is rendered probable by the remarks of Mr. Mead (Can. ent., iv:217), who found an *astyanax* on whose upper surface the blue was supplanted by fulvous "except in the marginal lunules, which are white with a faint bluish tinge;" and also of Grey (Ibid., xi:17), who says he possesses "a melanitic form of *disippus* [*archippus*] with all the markings of *ursula* [*astyanax*] on the under surface."

Egg (64:12). Surface smooth, with deep cells of a rounded ovate form, but angulated and of the same size as in the previous species; the thread-like filaments are similar to those of that species, but are slightly curved at tip and are longer near the summit of the egg than on the sides, being .1 mm. long at the summit, and about .06 mm. long on the sides. Micropyle, .154 mm. in diameter. Color when laid, shining, bright yellowish green, afterwards becoming blackish in the middle and green and yellow on opposite sides. Height exclusive of spines, 1.12 mm.; width, 1.18 mm.

Caterpillar. Third stage. Head paler brown than the body, heart-shaped above, beset around the sides with little tubercles. Body brown above, whitish beneath, with an oblong, triangular, whitish patch on the back of the fourth to seventh abdominal segments; two little blackish tubercles beset with very short spines on the top of the second thoracic segment. Length, 15 mm. (After Harris.)

Fourth stage. The tubercles have now become elongated; the top of the second thoracic segment has become distinctly pale or whitish, and the white patch on the back is larger; there is a whitish elongated triangle extending along the sides of the hinder extremity, from the hindmost feet to the side above the penultimate feet; there are oblong tubercles or elevations in pairs on the top of the third thoracic, second, seventh and eighth abdominal segments. Length, 32 mm. (After Harris.)

Last stage (74:17, 21, 25). Head (78:30) brownish red, with a moderately broad, obscure, pale, flesh-colored band, passing down the front on either side of the middle, the punctures paler; tubercles of the outer edge pale, the others partaking in general of the color of the region they are in, the large one on the summit of each hemisphere, which in this species is very nearly spherical with small projections, dark brown; a few very short, erect, pale hairs on the front of the head. Basal joint of antennae pale luteous, second joint dark castaneous; ocelli black.

Body smooth. First thoracic segment very pale, dull purplish, marked slightly with blackish; prominent parts of the second and third thoracic segments paler, between them often mottled with paler purplish, livid and blackish, at other times like the parts about, but obscured a little with dull purplish brown; first to third abdominal segments dark reddish brown, the first tinged with olivaceous, the sides of all three with a narrow, whitish, substigmatal band, sometimes tinged very slightly with purplish, sometimes very distinct or lively in color, occasionally of a creamy tint; the third abdominal segment has a subdorsal, pale purplish, bent line, the angle outwards; the fourth is marked above with very dull, pale purplish, the fifth and the dorsum of the sixth of the same color, the latter marked with fuscous; the rest of the fifth and the seventh and eighth abdominal segments dark reddish brown, tinged and streaked faintly with olivaceous; from the seventh segment backward there is a narrow, whitish, substigmatal band, broadening between the eighth and ninth segments; the hinder part of the body is blackish fuscous; elongated tubercles of second thoracic segment (86:60) blackish brown, cylindrical, almost the whole surface studded as closely as possible with conical pointed warts, usually about as long as broad, directed a little towards its apex, and at their tip curving in the same direction, giving the tubercle a greatly thickened appearance. The tubercles are directed outward at right angles to each other, but are not inclined forward or backward. The other laterodorsal tubercles are usually white or whitish. The minute warts scattered over the body are smooth, hairless, and usually shining steel blue, those upon the dorsum occasionally colorless, and those below the stigmata (sometimes) partaking of the color of the surface on which they occur. Spiracles brown, encircled with black. Legs rather

pale reddish brown. Prolegs brownish fuscous, clothed with fine, not long, downward directed hairs; the tubercles of the tip white. Length, 34 mm.; length of thoracic tubercle, 5 mm.; tip of thoracic tubercles 8 mm. apart; base of thoracic tubercles 4 mm. apart; breadth of body, greatest, 5.5 mm., least, 3.5 mm.; breadth of head, 4 mm.

Chrysalis (83:12, 13). Head, wings and the appendages in front, pale, brownish, shining yellow, the appendages often paler, the posterior edges of the wings a little darker; summit of head bluish white; thorax pale, discolored lilac, the pronotum with a pair of silvery white spots; dorsal tubercle of second abdominal segment, dark brown; on either side of it a broad, fuscous band, subparallel to the border of the wings, extends from the middle of the first segment, where the two unite, to the middle of the fourth segment, where they are more widely separated than the width of the tubercle; between this band and the wings the abdomen is occupied by a broader, oblique, nacreous band; rest of the abdomen to the seventh segment inclusive, cream-colored; the seventh segment has a dorsal and lateral patch of dark yellowish brown, and there is a broken dorsal line of the same extending forward nearly to the great tubercle; beneath, the fifth to seventh abdominal segments are obscure fuscous, with a cream-colored ventral stripe; terminal segments and cremaster dark yellowish brown; the eighth segment has a cream-colored patch at the spiracles. Spiracles horn-colored with white lips. Length, 23.5 mm.; height at thorax, 7 mm.; height at abdominal tubercle, 10 mm.; breadth of abdomen, 5 mm.; near tip of wings, 9 mm.; at base of wings, 8 mm.; at head, 3.5 mm.

Distribution (19:3). The range of this butterfly is similar to that of the preceding species (*archippus*) though less extensive; its boundaries are the Atlantic coast on the east, the Gulf of Mexico on the south, the Mississippi valley on the west, and about the 43d parallel of latitude on the north. Messrs. Allen and Austin found few specimens in Iowa, and Mr. Parker says it is rare at Grinnell; it has been taken at Ames (Osborn), and Davenport (Putnam), in the same state. It occurs also in eastern Nebraska (Dodge), and eastern Kansas (Snow), and in a varietal form (*arizonensis*, which may prove distinct) in Arizona and New Mexico. Strecker says it is even found in Mexico. Mr. Riley did not find it abundant in eastern Missouri; on the north it is found at Beloit (Chamberlin), and is "common" at Racine, Wisc. (Hoy), but "not common" in southern Michigan (Harrington Cook), "frequently seen" in northern Illinois and Indiana (Worthington), where Mr. Boutell has found it at Evanston; "occasionally found in a few localities" at Cleveland, Ohio (Kirkpatrick)*, "found occasionally" about London (Saunders), and at Essex County, Ont. (Lowe), the only known localities in Canada. It has been taken in twenty counties in Pennsylvania (Conradi), at Staten Island (Davis), and in New York at Rochester, "not common" (Bunker), near Albany (Lintner, Gray), and at West Farms, N. Y. (Angus).

It is tolerably abundant in the southern portion of New England, tolerably common in the central Connecticut valley, and occurs about as far north as the annual isotherm of 45°, the northernmost points recorded

* Kirtland, probably, however, speaking of species. He collected in southern, as well as the whole of Ohio, calls it an "abundant" in northern Ohio.

being Dublin (Faxon), Suncook "two or three" (Thaxter), and Milford, N. H., "common" (Whitney), and Williamstown, Mass., not rare (Scudder). Mr. Lyman, who took specimens about Portland, Me., which he once considered *astyanax*, now looks on them as *proserpina*.

Stoll' in his first illustration of the butterfly reports it from Africa!

Oviposition. The eggs are laid on the upper surface of leaves at the very tip, after the manner of the genus. I am indebted for specimens to Miss Guild and Messrs. Angus and Emery.

Food plant. The caterpillar is polyphagous, living on the leaves of several families of exogenous plants, very diverse in structure. It appears to be particularly addicted to Rosaceae, having been found feeding or laying eggs on plum, wild cherry (Abbot, Edwards), hawthorn, apple (Harris, Edwards, Dimmock, Lintner, Jack), pear (Angus, Miss Guild), and quince; it was also found by Abbot on gooseberry (Grossulaceae), and on *Vaccinium stamineum* (Ericaceae); while among the apetalous families, the Cupuliferae are represented by the hornbeam (*Carpinus americana*), and the scruboak (*Quercus ilicifolia*), on which Harris and Lintner found it; and the Salicaceae by willow (Abbot, Kirtland, Edwards, Mundt, Jack), poplar (on which an enclosed female lay for me), and aspen (Edwards).

Habits of the caterpillar. While feeding, it rests upon the upper surface of the leaf, eating the edges from the apex to the base, invariably returning to the same spot at each meal until all is devoured excepting the basal half of the midrib, when it passes to the adjoining leaf.

After eating, the caterpillar assumes a very peculiar posture, which the contour of the body renders still more grotesque; the anterior half of the body is strongly arched, the upper portion of the front of the head just touching the ground; the thoracic horns are thus thrown menacingly forward and all the true legs and the anterior pair of prolegs are raised above the ground; nor is this all, for the hinder extremity is also raised, the prolegs of the sixth abdominal segment barely touching the ground, and the parts behind lifted high in the air and thrust horizontally backward, so that the tubercles of the eighth and ninth abdominal segments are brought on a level with the anterior hunch; while the anal prolegs are so retracted as to be nearly concealed.

Life history. The history of this species, as I translate the facts, is similar to that of *B. arthemis*. It is partly single, partly double brooded, the half-grown caterpillars hibernating. These probably resume feeding as soon as the leaves of their food-plant begin to burst, but they feed slowly; Dr. Harris once found one, apparently in its third stage ("not more than .6 of an inch long") as late as June 17; it was "very sluggish, ate very little and grew slowly," not changing to chrysalis until July 8. The caterpillars change in June and July, the pupal state con-

tinuing ten or twelve days,* and the butterflies appear in the southernmost parts of New England (and probably in the Connecticut valley), from the 5th to the 10th of June, though only in limited numbers; in the latitude of Boston they seldom appear before the 18th or 20th, although single specimens have been seen by the 12th or 15th, and they do not become abundant before the close of the month. The butterflies continue to emerge from the chrysalis until nearly the middle of July and are still seen in early August. The eggs are laid in July, at least as early as the 10th and some at least of the butterflies produced from them are on the wing long before the middle of August, seldom appearing about Boston before the 20th, but in the Connecticut valley a week or more earlier, and flying through the month of September. Owing perhaps to the attacks of parasites which persecute only the summer brood of caterpillars, or more probably to the peculiarity of its history, which seems to be similar to that given by Gärtner for *Nymphalis aceris* (i. e. that some of the August caterpillars grow to maturity the same year, while others grow more slowly and hibernate when half grown, the spring brood of butterflies being thus made up from both broods of the previous year's caterpillars—see under *Basilarchia*) this second brood is considerably less abundant than the first and does not last so long, specimens of the earlier generation being seen even after the appearance of the second brood, while of the latter all have disappeared early in October; these lay their eggs at the very end of August and in September, and the caterpillars hibernate after the first or second moult.

Dr. Harris is quite mistaken in saying (*Ins. inj. veget.*, 3d ed., 283), that “the caterpillars of the last brood remain in the chrysalis state throughout the winter and are changed to butterflies in the months of April and May following;” the second brood of caterpillars would not have time to reach the chrysalis state before the advent of cold weather and there are no memoranda of capture of the butterfly in those early months among Dr. Harris's manuscripts; if they were so taken they were probably butterflies which had hibernated as such, like the possible single instance Mr. Lintner records for *B. archippus*.† This is rendered the more probable from the fact that Dr. Chapman has taken a single specimen in Florida as early as February 20, while the earliest bred by Abbot were disclosed on April 12. There are probably two broods in the south previous to the late summer brood, the first appearing before the middle of April and lasting until after the appearance of the second brood, which seems to be more abundant than the first; it appears early in June and continues to emerge from the chrysalis until nearly the last of July, and to fly through

* In the southern states, according to Abbot, from seven to nine days.

† It was doubtless subsequently to writing

this extract that Dr. Harris became familiar with the hibernacula of the species of *Basilarchia*; cf. his *Entom. corresp.*

August; such at least is the history as it appears from the few data found among the notes of Dr. Chapman, Abbot and Gosse.

Habits, flight, etc. The butterfly is addicted to roads, especially such as are partially shaded, to forest paths, and warm sandy places bordering on woods, thus combining to a certain degree the habits of archipus and arthemis; "secluded nooks in the margins of woodlands," says Maynard. More than either of its New England congeners, it is extraordinarily attracted by dung, the juices of which would seem to afford a strange satisfaction to so magnificent a butterfly. Except while eating, it is shy and difficult to secure. Dodge relates (Can. ent., vi: 115), that "upon more than one occasion, by wetting my fingers with apple juice, and holding them near an ursula as it sat upon a leaf above me, I have induced it to leave its perch and alight on my hand, where it would remain until the last drop was sucked up." Harris notices that it is persecuted by *Papilio polyxenes*. Its flight is similar to that of the preceding species but still more lofty and grand, more leisurely and sweeping, or, as Maynard characterizes it, "strong" and "well-assured." When at rest in the shade the wings are placed back to back, the body usually raised at an angle of about 15° to 20° , and the antennae, extended in the same plane with the body, are spread at an angle of about 55° , being about 16 mm. apart at the tip; viewed from above, the antennae are curved a very little in the middle.

Mimicry. In remarks under the genus I have quoted Doubleday's comment on the "singularly strong analogy" which the colors of this butterfly have to those of *Laertias philenor*, and others have mentioned it as a possible case of mimicry. Apart even from the very different form of the wings in these two species, their markings do not seem to me to have any striking resemblance, and I should be loth to look on it as anything but the weakest possible form of mimicry, a possible first stage toward it. But on the other hand there is certainly a very surprising resemblance between the females of *Basilarchia astyanax* and *Semnopsyche diana*, and in this case there can be no doubt that the latter is the mimicker, since it obtains its resemblance by departing from the ground color not only of the opposite sex, but that prevailing in both sexes in the whole tribe of *Argynnidi* to which it belongs. Moreover, *B. astyanax* occurs wherever *S. diana* is found.

Experiments with cold. Mr. Edwards "placed one chrysalis at four hours old on the ice and kept it there thirteen [?] days. From this came a large female after nine days, or at the period usual for this species. This shows some peculiarities which may or may not have been owing to the exposure. . . . The black band [preceding the submarginal spots on hind wing] is narrowed to one-half that of any other in my collection, and instead of being uninterrupted, it is crossed next costal margin by three of

the discal spots . . . which become confluent with the submarginal spots" (Can. ent., 16, 236). This would seem to be more like suffusion pure and simple than the slightest approach toward any other existing form in the genus.

Enemies. The late Mr. C. A. Shurtleff obtained a small green and bronze chalcid from the chrysalis of this species on July 11, but it has not been determined.

Desiderata. In order to determine its northern limits in New England, search should be made for this butterfly particularly between the 43d and 44th degrees of latitude and also along the whole sea-coast, at least as far as Grand Menan. All observations on the appearance of the imago in the early spring should be recorded in order to settle the question of its possible hibernation; and nearly or quite all the desiderata noted under the previous species are also applicable here; this species more than either of the others is likely to have a history similar to that of the European *Nymphalis*, and careful search should be made to determine whether any of the summer brood of larvae stop eating and hibernate. Mr. Edwards claims that the second brood of butterflies is a superfluity as it were, and that the eggs are always immature in the female of this brood; or that if by chance any were laid there would not be time before frosts for the caterpillar to reach the hibernating stage. Direct experiment and observation on this point are much to be desired. Fresh females found during August should be placed with males over their food plant; if eggs were laid they should be guarded from birds and parasites, but left out of doors in otherwise natural conditions; if no eggs are laid, the condition of the ovaries should be determined by dissection. Parasites should be sought.

LIST OF ILLUSTRATIONS.—*BASILARCHIA ASTYANAX*.

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| <i>General.</i> | <i>Chrysalis.</i> |
| Pl. 19, fig. 3. Distribution in North America. | Pl. 83, figs. 12. 13. Side view, colored. |
| <i>Egg.</i> | <i>Imago.</i> |
| Pl. 64, fig. 12. Plain. | Pl. 2, fig. 8. Male, both surfaces. |
| <i>Caterpillar.</i> | 33: 15. Male abdominal appendages. |
| Pl. 74, fig. 17. Colored, side view. | 52: 9. Side view of head and appendages enlarged, with details of the structure of the legs. |
| 21. Colored, dorsal view. | 61: 33. Papilla of tongue. |
| 25. Plain, side view. | 53. Extremity of tongue with several papillae. |
| 78: 30. Front view of head, last stage. | |
| 86: 60. Tubercle of second thoracic segment, last stage. | |

BASILARCHIA PROSERPINA (ASTYANAX-ARTHEMIS).

The bastard purple.

Limenitis proserpina Edw., Proc. Entom. soc. Philad., v: 148 (1865); Trans. Amer. entom. soc., i: 286-287, pl. 4 (1867); Butt. N. Amer., i, *Limenitis* 1, figs. 1-4 (1869).

Limenitis arthemis formproserpina Edw., Can. ent., ix: 114 (1877); Butt. N. Amer., ii, *Limenitis* 1, figs. 5, 6 (1879).

Basilarchia arthemis var. *proserpina* Scudd., Bull. Buff. soc. nat. sc., ii: 249 (1875).

Basilarchia astyanax (pars) Scudd., Syst. rev. Am. butt., 8 (1872).

Limenitis ephestion Lyman, Can. ent., vi: 38 (1874).

Figured by Glover, Ill. N. A. Lep., pl. I, fig. 18, ined.

Yes! There came floating by
Me, who lay floating too,
Such a strange butterfly!
Creature as dear as new:
Because the membraned wings
So wonderful, so wide,
So sun-suffused, were things
Like soul and nought beside.

BROWNING.—*Fine at the Fair.*

This butterfly (2:9), which I regard as a hybrid between *Basilarchia astyanax* and *B. arthemis*, can be briefly described as a butterfly of the size of *artemis*, having the coloring of *astyanax*, with the addition of the outer edge of the broad white bow of *artemis* often confused with bluish scales. The upper surface of the wings has the same general tone of color as prevails in *astyanax*, but shows, particularly on the fore wings, a narrow arcuate stripe of white or bluish white scales, following very closely the position of the outer limits of the belt found in *artemis*. On the hind wings this is frequently wanting or replaced by the bluish or greenish scales peculiar to the outer border of the hind wings of both species. Sometimes between this and the double marginal row of bluish lunules, there appears a series of minute orange-red spots in the interspaces, which are surmounted more or less distinctly by the bluish scales which form the outer border of the *artemis* band. Beneath, the ground color of the wings is that of *artemis* rather than of *astyanax*. But here the arcuate white stripe is generally seen with greater distinctness than above, and on the fore wings is usually broader, especially near the middle of the wings; while on the hind wings, though narrower, it is more distinctly whitish, losing very much the bluish cast found upon the upper surface.

On the fore wings the outer border of the stripe is better defined than the inner, and curves by a series of waves to the costal spot just beyond the middle of the wing, which now forms a part of it; the curve is most prominent and a little bent at the discal cell. The stripe is always divided by the nervules and obscured more or less by the greenish blue and dark blue scales, which become more and more noticeable away from the outer margin. On the surface of the fore wings the belt is usually as broad as the width of the cell, but is sometimes reduced to a narrow stripe often broken and equally faint throughout; sometimes even merely to one or two faint spots. On the hind wings, however, it generally forms a distinct band of varying breadth, but never equal in width to the stripe of the fore wing, and generally very narrow. Occasionally, as on the upper surface, it extends with lessening intensity some distance toward the base.

This hybrid shows a tendency to vary in the direction of *B. arthemis* in the northern part of its region, while in the southern portion the exact opposite is true; that is, it shows a tendency to vary toward *B. astyanax*. This is exactly as we should expect to find on the hybrid hypothesis; for the specimens toward the north should show a greater infusion of *artemis* blood, and those toward the south a greater of that of *astyanax*. In the collection of Mr. Mead, now owned by Dr. W. J. Holland,

I many years ago saw a specimen taken in the Catskills, probably the same as that figured by Edwards in his illustrated work, in which the upper wing is altogether as in arthemis, excepting that the outer limit of the white belt is powdery and the band somewhat narrower than usual; while on the hind wing only the inner border of the band is marked, as a narrow powdery stripe of bluish scales. Another from the same district, according to Mr. Edwards, has the belt narrow and macular on the upper surface and generally pure white, but on the upper half of the fore wing crooked and indistinct: while on the hind wings the belt is very narrow and does not cross the entire wing. Another specimen sent to me by the late Mr. F. G. Sanborn, has a very pronounced whitish belt on the under surface of the front wings and no whitish markings whatever on the hind wings. A similar specimen appears to have been recorded by Mr. Lyman of Montreal in the Canadian Entomologist.

Relations to other forms. When proserpina was first described, there was no doubt in the mind of the describer, nor of any one else, that its specific virtue was irreproachable. When, however, five years afterward, I came to study the presumed species for this work, for which I had seen a considerable number of specimens, I came to the conclusion that it was only to be considered a variety of *B. astyanax*, and I embodied this conclusion in the Systematic Revision I published in 1872. This view was at once criticized by Mr. Grote and others, and at the close of 1873, Mr. Edwards (*Can. ent.*, v: 232), expressed the opinion that it would probably prove a dimorphic form of *B. arthemis*. It was not until four years later that he reached success in breeding experiments, which proved that from eggs laid by a female proserpina there resulted both proserpina and arthemis; a definite relation to arthemis was thus fully proved. Meanwhile the discovery of other varieties of proserpina, especially one I saw in Mr. Mead's collection, the counterpart, if not the original, of figure 6 in Edwards's last plate, convinced me that my earliest conclusion was incorrect, and I accordingly placed it as a dimorphic form of arthemis in the Buffalo Bulletin in 1875, but with the remark that it was "very probably a hybrid of arthemis and astyanax."

That suggestion the breeding experiments of Messrs. Mead and Edwards in no way disprove, and I am disposed still to support it. In the single instance where proserpina and arthemis were produced from eggs laid by one individual, the mother was known to be proserpina, but the father was probably arthemis, as the latter flies in the region of the experiment in the greatest abundance.

My reasons for maintaining the hybrid theory, are the following:—

1. Several instances of undoubted hybridism are known in the genus *Basilarchia*. It seems to lend itself with exceptional readiness to this peculiarity.

2. Proserpina partakes of the characters of the two species mentioned, but most nearly resembles *astyanax*, while its intimate relation to arthemis has been proved by experiment; it possesses, in fact, just the characters we should expect of a hybrid between these species. It varies most toward

astyanax where this prevails, and most toward arthemis where that prevails.

3. A careful comparison of a considerable series shows that there is no difference whatever in the genital armature of proserpina and astyanax.

4. Proserpina varies more than either of the supposed parents and approaches astyanax so closely that one with so keen a perception of superficial distinctions as Mr. Edwards, cannot determine of certain specimens whether they should be classed with astyanax or with proserpina. Speaking of nine specimens sent him from Milford, N. H., Mr. Edwards says: "The first three spoken of I have no doubt are true proserpina, and probably all the others are, though they cannot be distinguished from some examples of ursula [astyanax], taken in certain districts where arthemis is never known to fly. . . . Therefore, I cannot say that all these Milford examples are not proserpina; and, indeed, I do not know where proserpina ends and ursula begins, though a typical example of each is distinct enough." (Butt. N. A., ii.).

5. Proserpina occurs only in a very narrow belt across the eastern third of the continent—a belt which forms the southern boundary of the range of arthemis and the northern boundary of the range of astyanax.

6. Proserpina is known at so many points in this belt, that it presumably occurs *wherever* arthemis and astyanax are brought into contact.

7. Although regional dimorphism is known in many instances, there is no dimorphic butterfly known in which one of the forms is wholly limited to the *confines* only of its regional distribution and at the same time extends over a long distance; nor, so far as I am aware, has any such case been recorded among other dimorphic animals.

There are but two arguments used to prove the improbability of such a relationship as is here urged: 1°. To assert that proserpina occurs in some districts where astyanax is not found, but occurs in no districts where arthemis is not found. 2°. That specimens which had once been looked upon as proserpina, are a northern form of astyanax which, in a belt of "several degrees of latitude," lives "side by side with the southern form."

As to the first, there is but a single place where proserpina has been found, where it is probable that astyanax does not occur within at least an easy day's flight; a distance of a few miles is of no account whatever. Hamilton, Ontario, is on the same parallel as London and Rochester, and only seventy-five miles from the former. Portland, Me., is at no greater distance from the more elevated, and but slightly more southern localities in New Hampshire, whence astyanax is known. The only place that need concern us in Halifax, N. S., three hundred and fifty miles from the New Hampshire coast, from which in a single instance, nearly twenty years ago, proserpina has been reported, of which Mr. Edwards wrote in 1870: "I

think the figure [a colored drawing] is of *proserpina*; the white band is unusually broad on the upper surface." This single example, due possibly to the union of an *arthemis* with a *proserpina* which had followed the coast northeastward at an average rate of a dozen miles a day, should not be considered as in any sense an impossibility, nor is it necessary to assume so much as to suppose it the result of a single season's accident. It is not at all improbable that *ursula* may yet be found as far as Mt. Desert, and that colonies of *proserpina* are now living along the whole coast of Maine; negative evidence from a region where collectors are so few and sparsely scattered, has but little value. Nor is it at all improbable that the specimen in question may not be a genuine *arthemis*, varying (possibly by reversion) toward an allied species of similar ancestry.

The second objection has no weight whatever, especially if we look upon *astyanax* (as the last suggestion above possibly indicates), as nearer the ancestral form from which both descended; for where hybridity and a tendency to reversion combine, there we should look for an easier mingling of these characters, and the "northern form" of *astyanax* would result as a further approach toward the southern, by the union of *proserpina* with the latter and would be perpetuated in the northern part of the range of *astyanax*, by the constantly renewed supply of new parents; that is, this form, very likely destined to eventual distinction, would not disappear by amalgamation with the true stock, receiving as it would, a constant infusion of new blood. The occurrence, therefore, of a "northern form" of *astyanax*, is rather an argument in favor of, than opposed to the hybrid theory of the status of *proserpina*.

In addition to this it has been noted by at least one observer, Mr. R. M. Grey of Kenwood, N. Y., that when flying in a restricted locality where *arthemis* is found and no *ursula*, *proserpina* varies towards its companion; while in the lower country a few miles distant where the opposite condition prevails, the variation is in the reverse condition. I quote his words, not written with the purpose of maintaining the thesis here upheld, but of the unity of all the species of *Basilarchia*.

Near the Hudson River I find *ursula* and *proserpina* in close association, each partaking of the markings of the other, evidently one brood, alighting on the same heap of pomace: expansion of wings three to three and a half inches. About six miles from the river *ursula* and *proserpina* are equally abundant, with a few *arthemis*; and rarely a *disippus*. Expansion of the wings of the four about two and a half inches; all found in one glade. From this to the highest tables of the Helderberg Hills, *ursula* gradually disappears and only *proserpina* and *arthemis* are found, the latter most abundant. In the low lands *disippus*, *ursula* and *proserpina* are only found; in intermediate broken lands *ursula*, *proserpina* and *arthemis* are chiefly found; at the highest altitudes only *proserpina* and *arthemis* are found, and examinations of many examples from the different localities show that these forms approach each other very closely (Can. ent., xi: 16).

Distribution (19: 4). As stated above, this form of *Basilarchia* is found

only (and probably everywhere) where the boundaries of *B. arthemis* and *B. astyanax* come into contact, occasional or permanent. The localities known to me by specimen, report or published statement (especially in Edwards's Butterflies) are the following, from west eastward:—Racine, Wisc. "in certain localities numerous" (Hoy); Evanston, Ill. (Boutelle); Wexford Co., Northern Michigan (Gibbs); Middle Michigan (Cook); Hamilton, Ont. (Murray), "rarely more than one in a season (Moffat), Buffalo, N. Y. (Linden); Monroe Co., Penn. (Conradi); Catskills, (Mead, Edwards) Albany and vicinity (Lintner, Grey), and besides New England localities, one far to the eastward, as mentioned above, near Halifax, Nova Scotia (Jones).

The only localities known to me in New England are the Graylock Hopper at Williamstown, tolerably common (Scudder), Holyoke, one specimen (F. H. Sprague) and Medford, Mass. (Sanborn); Milford, N. H. (Whitney) and Portland, Me. "occasional" (Lyman).

Life history. The life history of this form differs in no respect from that of its parents which, where they come into contact, wholly agree both in actual season and in general character. That a second supplementary brood of this form also occurs is shown by the observations of Lyman at Portland, who says: "Last year [1874] there was a second brood . . . which appeared about the end of August. I believe that this is the first time within the last six years that this has occurred there" (Can. ent., vi: 38.)

Desiderata. The one thing needed to settle the status of this form is to determine its relationship to *astyanax*. This can best be done in such districts as those in Mr. Grey's vicinity, where *artemis*, *proserpina* and *astyanax* are all found. One should attempt to procure the laying of eggs in *such a locality* by every ripe female obtained, to see whether the progeny in nine cases out of ten does not vary in the direction of *astyanax* quite as much as in that of *artemis*. Whether it would be possible in a large vivarium, as in the cold house of a grapery, where netting might cover the open windows and flowers be kept in bloom and willows grown in pots, to keep virgin pairs of male *artemis* and female *astyanax*, or the reverse (but not both) long enough to permit the laying of ripe eggs, I do not know; but anyone having an opportunity to try the experiment would do our science a service. Experiments should also be tried in localities where one of the parent forms is found almost to the exclusion of the other but in company with *proserpina*, to see whether females of the typical forms breed true or not, as they certainly do away from the boundary line.

LIST OF ILLUSTRATIONS.—*BASILARCHIA PROSERPINA*.

General.

Pl. 19, fig. 4. Distribution in North America.

Imago.

Pl. 2, fig. 9. Male, both surfaces.

BASILARCHIA ARTEMIS.—The banded purple.

[The banded purple (Gosse); *Artemis limenite* (Emmons); circled emperor (Ross); white banded butterfly (Maynard); sylvan *Basilarchia* (Scudder).]

Nymphalis phal. arthemis Drury, Ill. nat. hist., ii: 17, pl. 10, figs. 3-4 (1773).

Papilio arthemis Goeze, Entom. beytr., iii: i, 375 (1779).

Limenitis arthemis Say, Amer. entom., ii, pl. 23 (1825); Entom. N. Amer. ed. LeCoute. i: 49-50, pl. 23 (1859);—Blanch.-Brullé, Hist. nat. ins., iii: 451 (1840);—Gosse, Can. nat., 220-221, 3 figs. (1840);—Liutn., Proc. Entom. soc. Philad., iii: 62-63 (1864);—Ross, Butt. Can., 7, fig. (1873);—Edw., Can. ent., xi: 224-228 (1879); xiii: 237-242 (1881); Butt. N. A., ii, Lim. i: (1-20), pl. Lim. 1 (1880);—Middl., Rep. ins. Ill., x: 88 (1881);—Heust., Can. ent., xv: 57-58 (1883);—Fern., Butt. Me., 62-64 (1884);—Mayn., Butt. N. E., 10-11, pl. 1, figs. 11, 11a (1886);—French, Butt. east. U. S., 208-210 (1886).

Nymphalis arthemis Bois.-LeC., Lép. Amér. sept., 202-203, pl. 54, figs. 1-3 (1833);—

Morr., Syn. Lep. N. Amer., 65 (1862);—Harr., Ins. inj. veg., 3d ed., 283-284, pl. 1, fig. 7 (1862).

Nymphalis (Limenitis) arthemis Westw., Drury, Exot. entom., ii: 19, pl. 10, figs. 3-4 (1837).

Basilarchia arthemis Scudd., Syst. rev. Amer. butt., 8 (1872); Appal., ii: 331-336 (1881).

Nymphalis artemis Doubl., Catal. Lep. Brit. mus., i: 96-97 (1844).

Limenitis artemis Feld., Neues Lep., 29 (1861).

Limenitis ursula var. *artemis* [Hulst], Bull. Brookl. ent. soc., vi: 7 (1883).

Papilio lamina Fabr., Entom. syst., iii: 118 (1793).

Nymphalis lamina God., Encycl. méth., ix: 336, 330 (1810).

Figured by Glover, Ill. N. A. Lep., pl. 31 fig. 5, ined.

Mark, while he moves amid the sunny beam,
O'er his soft wings the varying lustres gleam.
Launched into air, on purple plumes he soars,
Gay nature's face with wanton glance explores;
Proud of his varying beauties wings his way,
And spoils the fairest flowers, himself more fair than they.

Quoted by Haworth.

Hearing you praised, I say 'Tis so, 'tis true',
And to the most of praise add something more.

SHAKESPEARE.—*Sonnet.*

Imago (2:5). Head covered with very dark olivaceous brown hairs with a small triangular white spot at the extreme back of the head, behind the base of each antenna; behind and adjoining the middle of the eye a narrow white streak, about half as long as the eye, partially obscured by brownish scales; occasionally a few pale hairs in front of the base of each antennae. Antennae uniformly velvety black, the extreme tip dull dark luteous or reddish. Palpi covered with dark olivaceous brown hairs, excepting on the apical two-thirds of the outer surface of the basal joint, and the lower outer half, as far as the middle of the under surface, of the other joints, which are clothed with white scales and hairs, slightly obscured by a few brownish hairs. Tongue very dark brown, blackish toward the base.

Thorax covered with very dark brown hairs, olivaceous when viewed from the side; a small white spot at the extreme base of each wing. Fore femora olivaceous brown, with a slender, faint, median line of white beneath; fore tibiae and tarsi covered with white scales and hairs, excepting on the inner side which is olivaceous brown; other legs dark castaneous brown, covered with mingled brownish and dirty white scales, the latter most abundant on the under surface of the femora and tibiae; coxae fringed exteriorly with long, pale, bluish white hairs and tipped with silvery white; spines dark brown; claws reddish brown; paronychiae pale testaceous, reddish toward the tip; pulvillus dark brown.

Wings above velvety chocolate black. *Fore wings* entirely resembling those of *B. astyanax* in form, but differing from those of *B. archippus* in their more curved costal and outer margin. Third superior subcostal nervule arising a little less than half

way from the origin of the second superior nervule to the tip of the wing; the fourth arising midway between the base of the third and the tip of the wing. Fore wings with a very broad mesial white belt, which scarcely fails of attaining either border, broken only by the black nervules which cross it and the few black scales which border the nervules for a short distance on the outer half of the belt; the belt varies slightly with each interspace and is usually broadest next the cell and in the lower median interspace; in the subcostal interspaces, its width is fully twice the breadth of the interspaces; its interior border is well defined, its exterior a little vague by the intermixture of white and black scales; the belt starts from a very little beyond the middle of the costal border and, curving outward, reaches the inner border at a distance from the outer margin equal to its own width; the interior margin of the belt is nearly continuous, but is almost always angularly indented to a considerable degree at and just above the lower median nervule; the exterior margin is less regular, being usually protuberant beyond the cell and in the lower median interspace and indented somewhat just below the lower median nervule; at the terminal divarication of the subcostal nervure there is a white dot and just within it, above and below the divaricating nervule, two small triangular patches of white scales; there is a faint, submarginal series of transverse, disconnected, bluish streaks in every interspace, distant from the border by about three-quarters the width of an interspace, and occasionally the slight indication of a second row between this and the border; fringe alternately black and white is about equal measure, the black next the nervure tips. *Hind wings* resembling in form those of *B. astyanax* in every particular, but differing from those of *B. archipus* in having the outer border pretty strongly crenulate, more strongly arched and slightly (♀) or rather conspicuously (♂) produced at the upper median interspace. First median nervule originating a little further from the base than the last subcostal nervule. A broad, white mesial band, similar to that of the fore wings and in continuity with it, is broadest in the middle and tapers slightly toward either end; its interior border is well defined, nearly straight, the middle two-thirds slightly convex; its exterior border is regularly convex and a very little powdery; the band starts from the middle of the apical two-thirds of the costal border and reaches the inner border at the middle of the apical half; this belt is followed exteriorly by a series of clustered blue scales, forming, in each interspace, lunular cappings to a row of small and usually rather inconspicuous, round, orange red spots, subparallel to the outer border; both of these rows of colored spots are often greatly subdued and occasionally absent; there is a double submarginal row of slightly curved, transverse blue streaks, one in each interspace, the inner slightly larger and more curved, distant from the margin by the width of an interspace, the outer midway between the inner and the border, each streak usually broken in the middle. Fringe white, interrupted rather broadly with black at the nervure tips.

Beneath: *Fore wings*; there is a mesial white belt partaking altogether of the character of that of the upper surface, excepting that it is slightly broader; within this belt the wing is of a rich, dark purplish brown, a little tinged with olivaceous beside the veins; the extremity of the cell is marked by a large, transverse, dark orange red spot, bordered with purplish black; and in the middle of the cell is another large, roundish or irregular spot of the same colour similarly bordered; both occupy the whole breadth of the cell, and on either side of the latter, at the uppermost extremity, is a slight patch of bright pale blue scales; a few inconspicuous blue scales are also scattered through the other unoccupied parts of the cell; the space between the costal nervure and the margin is dark orange red; outside the belt, the subapical white spots and the two submarginal rows of blue streaks found on the upper surface are repeated beneath, both of the latter with equal distinctness and on a purplish black ground; following the submarginal streaks, interiorly, is a rather broad dark red band, varying in tint from orange to cinnamoneous, most conspicuous above the middle of the median area; when it is of the latter tint, the space between this and the mesial belt—excepting the subapical white spots which are sometimes followed by other faint spots below in succeeding interspaces—is also cinnamoneous; otherwise it is of a dark olivaceous

brown, tinted sometimes with cinnamoneous; fringe as above but a little less white. *Hind wings* with a mesial belt exactly similar to that of the upper surface except in being slightly broader; within this belt, the wing is dark, rich, olivaceous brown, more or less enlivened with reddish orange or cinnamoneous scales; in the cell two spots situated and colored as those of the fore wings, but very narrowly margined with black, that at the extremity of the cell crossing also the lowest subcostal interspace; a similar oblique, oval, slightly smaller spot, barely bordered with black in the costo-subcostal interspace, directly above or a little outside of that in the middle of the cell; a few bluish scales, occasionally clustered in spots, are usually scattered about the cell and near the base of the costal nervure; sometimes they are of a metallic purplish blue, and sometimes they becloud nearly the whole base of the wing; costal margin at base broadly margined with dark orange red; beyond the belt the wing is purplish black, with a double submarginal row of curved streaks, like those of the upper surface but slightly larger; in each interspace between these and the mesial belt there is a large, roundish, dark orange red spot, occupying nearly all the intermediate space, sometimes only two-thirds as broad as the interspaces but usually nearly touching the nervules, and occasionally uniting to form a continuous band; fringe as above, excepting that the black occupies about the same amount of space as the white does, and in the submedio-internal interspace is white.

Abdomen purplish black, below with broad medio-ventral and narrow latero-ventral stripes of white, the former broader at the apices than at the bases of the segments. Appendages of male (33:9): hook of upper organ scarcely curved and equal on the basal three-fourths, beyond gently arcuate, tapering at first gently, afterwards more rapidly to a fine point. Clasps three times as long as broad, beyond the prominence of the lower edge tapering regularly but not greatly to a broad, rounded apex, but with a considerable rounded prominence of the upper edge in the middle of the basal two-thirds of the free portion, similar to that of *astyanax*; apex of clasp very nearly one-half as broad as the base, and armed with a few, small, pointed spines more distant than on *astyanax*, and extending also, much smaller, upon the apical portion of the lower edge; interior finger broad at base, tapering at first a little, afterwards scarcely at all, so as to be nearly twice as broad as in the other species, straight, directed upward and scarcely backward, scarcely free, excepting in the slight portion which extends above the prominence of the upper edge as in *astyanax*, covered with fine prickles, the tip very bluntly pointed.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 10.5						
Length of fore wings.....	30.	32.5	35.5	33.5		38.*
antennae.....	14.	15.	17.	15.		16.
hind tibiae and tarsi..	8.	9.	9.8	9.		9.5
fore tibiae and tarsi..	3.	3.25	4.	3.4		3.8

* One specimen taken near Boston by Mr. Thaxter had a fore wing 47.5 mm. in length!

Hybrids. B. PROSERPINA (ASTYANAX-ARTHEMIS). For the form *proserpina*, see the preceding section, where it is discussed as a hybrid between this species and B. *astyanax*.

B. ARTHECHIPPUS (ARTHEMIS-ARCHIPPUS) (*Limenitis arthemis*, aberr. C. Edw., Pap., ii: 47). Another case, more confidently to be referred to hybridism, is a male specimen in the Museum of Comparative Zoology at Cambridge, obtained at Chateauguay Basin in September, 1879, by Mr. J. G. Jack, and which is certainly to be looked upon as a hybrid between *artemis* and *archippus*.

The upper surface presents a curious commingling of the characters of the two species. The ground and the markings of the fore wings are mainly those of *archippus*, but the black has suffused itself so thoroughly as to melanize the entire wing, which only shows the proper orange ground in a somewhat obscured fashion in the cell, particularly at the base, in the lower median and medio-submedian interspaces,

and in the outer series of normally long orange lunules in the middle of the lowest subcostal, subcosto-median and upper median interspaces, here reduced to rather small circular spots. The broad white belt of arthemis is quite wanting and in its place is an exact repetition of the extra-mesial series of white spots descending from the costa found in archippus, as well as the pair of white spots next the costa midway between this and the apex, found alike in both species though more commonly single in archippus; the marginal markings are as in arthemis but somewhat subdued. The shape of the hind wings is that of archippus and so are most of the markings, the orange, though dulled and in the outer half of the wing much restricted, as a whole predominating; but in the exact position of the normal, transverse, black stripe is a conspicuous though narrow band of white, broken at the black nervures into transverse spots about twice as broad as long; and this white band, corresponding to, but more curved than the belt of arthemis, is bordered on both sides but especially without with black; and as the black margin of the wing is of unusual width (for archippus), the orange spots beyond the extra-mesial stripe are, as in the front wings, vastly reduced, being scarcely longer than broad; the only markings of the marginal band is a single row of faint and slender blue lunules and the white interruption of the dark fringe.

Beneath, the resemblance to arthemis is a little stronger; for though in the main, the markings of the upper surface are repeated (with rather more prominent fulvous ground), the immediate margins of both wings are built on the arthemis pattern, and indications of the varied mottling of the base of the hind wings faintly appear, though only in paler and deeper fulvous, while the spots forming the white extra-mesial band are scarcely broader than long. Length of fore wing, 32 mm.

The specimen described by Edwards is very similar to this and was also found in Canada. It approaches arthemis a very little more closely than the one above described.

The occurrence of two such similar forms renders it probable that they are not altogether uncommon; and I have therefore thought them worthy of a distinctive name.

Egg (64:15). Grayish green, the filaments white (after Edwards); micropyle (67:5), according to a drawing by Konopicky, with about a dozen rather large, kite shaped cells around a central circle, surrounded by only one or two rows of small polygonal and subisohedral cells before the larger filament-bordered cells are reached.

Caterpillar. *First stage.* Head (78:21) glossy brown. Body above and below yellow brown, the tubercles concolorous, excepting those of the uppermost rows which are darker; hairs white; prolegs and legs concolorous with body. Length, 2.3 mm. (After Edwards.)

Second stage. Head (78:22) wood brown, but the whole front black. Body wood brown, more or less obscured with dusky tints especially at the incisures; tips of the tubercles and their papillae slightly paler than the ground. Length, 5 mm.

Third stage. Head (78:23) black, its hinder surface wood brown. Body blackish brown, varied with clay yellow on the hinder edge of the dorsum of the fourth and the whole of the dorsum of the fifth abdominal segments and on the sides of the last abdominal segment; papillae of tubercles wood brown, especially on the upper surface. Length, 10 mm.

Fourth stage. Head with the tubercles more prominent at the summit than elsewhere, those at the back and sides long, conical and separated; color blackish, the upper parts suffused with red, the summit, sides and sutures red, the tubercles mostly concolorous with the ground. Body red-brown, somewhat specked and mottled, especially at the incisures, with black, the tubercles ferruginous red or partly castaneous, the mammiform dorsal elevations of the second abdominal segment castaneous, the dorsum of the third to fifth abdominal segments and most of the sides of the fourth yellowish, and an infrastigmatal gray buff stripe on the sixth and succeeding abdominal segments, previous to which it is brown. Most of the tubercles red. Length, 11.2 mm. (After Edwards.)

Last stage (74:26). Head (78:24) dark drab, the coronal tubercles obliquely truncate; ocelli black. Body of various shades of green, especially olive, the dorsal patch

whitish or sordid buff, the anterior segments more or less whitish and an infrastigmatal stripe pink, excepting on the last segments where it is white, the mammiform protuberances and transverse ridges, especially the latter, olive, the ridges beset with blue lenticular or subconical papillae. Longer tubercles of second thoracic segment amber, of sixth and seventh abdominal segments black. Legs and prolegs red-brown. Length 30 mm. (Colors mostly after Edwards.)

Chrysalis (83: 14, 23). Ocellar tubercles less prominent than in *B. archippus*, and dorsal surface of eighth abdominal segment less rugulose, the roughnesses more smoothed. Color varying from a creamy white to silvery gray, excepting along the upper and hind margins of wings, which vary from dark brown to greenish, and the dorsal prominence of the second abdominal segment, which is fuliginous but separated from the wing-cases by a band of silvery gray. Abdomen yellow white, the terminal segments and whole ventral surface excepting a ventral line grayish brown, and a dorsal and obscure suprastigmatal stripe of brown. Length, 21-25 mm.

Distribution. This species of *Basilarchia* has a very different range from the others, its southern limits nearly coinciding with the northern boundaries of *B. astyanax*. It is *par excellence* a Canadian species, inhabiting the whole width of the Dominion east of the Rocky Mountains and extending far north into unexplored regions. The following are some of the localities where it has been found north of our boundary, passing from east westward: Nova Scotia, "quite common in particular localities," (Jones) and at Parrsboro (Mrs. Heustis); Cape Breton (Thaxter); Newfoundland (Edwards); Godbout River on the northern shore of the Gulf of St. Lawrence (Corneau); on the southern side of the same Gulf in the River Rouge District (D'Urban), at St. Anne and Marsoime Rivers (Bell), Quebec "not uncommon" (Bowles, Fyles); Montreal "not abundant" (Caulfield); Sherbrooke (Gosse); Chateauquay (Pearson); Ottawa (Fletcher); York County, London, and Hamilton, Ontario (Brodie, Saunders, Murray (Moffatt); Moose Factory, Hudson Bay (Weir); Lake of the Woods (Say, Dawson) and Dufferin (Dawson); Lake Winnipeg (Say), mouth of the Saskatchewan (Scudder); Athabasca region (Geffcken); Fort Simpson (Edwards); McKenzie and Slave River (Richardson); Devil's Portage, Liard River (Dawson fide Fletcher). The last localities carry it to the Rocky Mountains in the high north, but there is no other authentic record of its reaching so far west at a more southern latitude, excepting that it was taken by Tyrrell, at Red Deer River, latitude, 52 N., longitude, 114° 20' W.; unless Captain Geddes, who vaguely reports it from the "Northwest Territory" (by which he means all the Canadian possessions between Winnipeg and the Rocky Mountains) has found it there; or unless also Reakirt's statement is correct that he has specimens from Colorado, from which state no one has since brought it. Strecker, however, credits it as extending to the Pacific, but with no specific statements of localities. Mr. Fletcher informs me that there is a specimen in Geddes's collection marked California. It has not been reported from Labrador or Alaska. Within our own country it has been found—passing now from west, eastward—in the "Arkansas" of 1820,

[possibly *B. Weidemeyeri*] (Say), St. Cloud, Minn. (Hulst), Iowa (Chicago Mus.), both ends of Lake Superior (Hulst), and its northern shore (Agassiz, Fletcher, Mus. Mich. Univ.), Racine, Wis., "rather rare" (Hoy), "common" (Kirtland), northern Illinois (Worthington, Chic. Mus.), northern Michigan (Cook), Kalamazoo, Mich., "not common" (Gibbs); Poland "in two or three instances" and Cleveland, O., "among the most rare species" (Kirtland), Monroe and Pike Counties, Penn. (Conradi), and in New York, not only in the Adirondacks (Hill), and Catskills (Mead, Edwards), but also at Lima (Mark), Rochester (Bunker), Auburn (Parker), Potsdam "very scarce," Albany and Schoharie Counties (Lintner), and Nichols (Howell). Very many of these localities are drawn from Edwards's careful account of this butterfly.

In New England it has not been taken south of Massachusetts and but rarely in that State. It is not uncommon among the Berkshire Hills at Williamstown (Scudder), and it has been taken sparingly at Deerfield (F. H. Sprague), among the hills between Amherst and South Hadley (Dimmock, Stearns, F. H. Sprague, Goodell, Marsh), at Belchertown (Dimmock), Holyoke (Emery), and Templeton (Partridge). It has occasionally been found about Boston, especially at Dorchester (Clapp, P. S. Sprague), Malden and Wollaston (F. H. Sprague), and even at Walpole (Miss Guild). It is already common at Factory Point (Roberts), and Brattleboro, Vt. (Higginson); at Walpole (Smith), Weare (Emery), Suncook (Thaxter), and Dublin, N. H. (Faxon, Leonard), but is "scarce" in Milford near the latter place (Whitney), and is even considered "not abundant" at Portland, Me. (Lyman). In the White Mountain region, and in northern New England generally, it is exceedingly abundant, far more so than the other species of the genus in their most favorable localities. Indeed the matrons of farm-houses in the valley of the Peabody River complain of the insects entering the kitchens in such numbers as to be a very nuisance; one of them, Mrs. Dolly Copp, of "Imp Cottage" (well-known to many old frequenters of the Glen), relates how she has taken more than fifty on the inside of her windows in a single morning; and "Mr. Hill saw, on one occasion in the Adirondacks, a log closely packed with arthemis, standing side by side."

Haunts and abundance. This butterfly frequents the shady roads through the forests of northern New Hampshire, especially where they are hilly; or it may be found equally about the margin of woods. Dr. Harris has remarked that it is particularly addicted to the flowers of *Eupatorium ageratoides* L. in open places in the White Mountain valleys.

Almost any opening in the deep woods will be frequented by it, especially if there be excrementitious matter or camp refuse about. Reference has already been made above to its abundance, to which may be added the following quotation from the Canadian experience of D'Urban:—

"It frequently assembled in astonishing numbers round old lumbering camps etc., congregating about the tea-leaves and other refuse lying about such places. On the 15th of July, on the site of a lumbering camp and timber rollway, on the bank of the Rouge, about three miles above the Indian Village in the township of Arundel, I saw the most extraordinary assemblage of butterflies I ever beheld, several hundreds of this species being congregated together in groups consisting of from twenty to fifty individuals in each, whilst many others flew around and rendered it difficult to arrive at an accurate estimate of their numbers; nevertheless, I am convinced that I am within the mark, when I state that there were more than three hundred assembled within a space of a few square yards." (Can. nat., v: 89.)

It is one of the delights of camp life in northern New England to meet this butterfly.

Oviposition. The eggs are laid singly, close to the tip and upon the upper surface of the finely tapering leaves of the food plant, so near the tip that the egg is just about as wide as the leaf at that point. They are laid almost exclusively upon horizontally extended branches of small plants, not more than two or three feet high, skirting roadsides. As abraded and ragged females may be found for a long time, it is highly probable that only a few eggs are laid in a single day, and that the mother continues her labors for several weeks. The eggs hatch, according to Edwards and Mead, in from seven to nine days.

Food plants. The plants credited with being the food of this species in the larval state are various and very different from each other, but some of them seem to require confirmation. I have myself found the caterpillar in the White Mountains exclusively upon black and yellow birch and willow (once upon poplar), belonging to neighboring families of plants, Betulaceae and Salicaceae; and I regard the first, *Betula lenta*, as its proper food by preference. Mr. Edwards has found it in the Catskills on aspens (*Populus*), a very closely allied plant. Lintner reared it on *Populus balsamifera*, and Gosse says he took the caterpillar "from an elm tree, on the leaves of which it was feeding," also a neighboring plant; all the above are apetalous plants. But Ross mentions honeysuckle* (*Caprifoliaceae*, a gamopetalous plant) as one of its foods, which surely needs verification: Mr. Saunders records the capture of a larva while beating some thorn bushes in London, Ontario, and Colonel Higginson has raised it from hawthorn in Brattleboro; while I found one last autumn making its hibernaculum on *Amelanchier*, another of the Rosaceae, to do which it was necessary that it should at least bite the leaves. Miss Middleton and Professor French of Illinois, state that it feeds on basswood (*Tilia*), a statement accepted by Edwards; all of these are polypetalous plants, very far removed from what seems to be its proper food.

Habits of the caterpillar. The young caterpillar, according to Mead, acts like the other members of the genus in that it remains at "the tip of

*Is it possible that under this name Ross and has mistaken *Amelanchier* for that refers to *Lonicera*, also called honeysuckle, plant?

the leaf, and there eats on both sides of the midrib, usually resting on the projecting end of this" as on a perch. It undergoes one or two moults before winter, during all this time resting, when not feeding, upon this perch or a similar one constructed from the next leaf it attacks; it then proceeds, after the fashion of Basilarchians, to construct a winter abode, generally from a leaf which it has been eating. These hibernacula are in all respects similar to those made by the other species of the genus; it begins to make them in the White Mountains, and even further south, by the middle of August, and it is sometimes as many as ten days in making one quite to its liking. Into such a little cylinder the caterpillar crawls head foremost, its tuberculate hinder end visible and forming a sort of living door to its abode; here it remains the winter through, and as it has lived up to this time on the same low plant on which it was born, it is buried in snow the greater and colder part of the winter. This I found by examining thousands of trees by the roadsides in the White Mountain valleys very early in spring before the leaves were fairly out, when search for the hibernacula was easiest, and I found that fully nine out of ten were within from two to three feet from the ground, much below the average level of the snow in that region. With the first starting of the leaves into new life the caterpillar backs out of its retreat and begins again to feed upon the tender green; but either it first changes its skin, or it returns to the perch of its dried up and inedible hibernaculum-leaf after its probably scanty meals, for these will nearly always be found, soon after the caterpillar has finally quit them, to have upon the apical flap, the cast-off pellicle of the caterpillar.

It may be added as a very interesting point, that there is a Notodontian caterpillar found in some numbers on the black birch in the White Mountain valleys, which eats the leaf in precisely the same way as *B. arthemis* does, and simulates its habits, even to taking its siesta on the denuded midrib of the apex of the leaf; but it makes no such pad of riff-raff next the ragged part of the leaf as *Basilarchia* does. A similar relation is noticed by Dorfmeister between the caterpillars of *Najas populi* and *Notodonta ziczac* of Europe, which feed in a very similar way on *Populus*.

Life history. Edwards and myself have held different views regarding the life history of this insect: and on reviewing both my own sources of information, including numerous observations by many others as well as by myself for many years, and the statistics he has so laboriously gathered and published, I am inclined now to think that we were both of us in part correct and in part wrong. As will have been seen above, the caterpillar hibernates in mid-life, and awakes with the dawn of spring, in the White Mountains in the latter half of May. It feeds for a few weeks, the chrysalis hangs for from nine to fourteen days (nine to ten, Edwards, ten to eleven, Scudder, ten to twelve, Saunders, "about a fort-

night," Gosse), and then the butterflies appear on the wing. In the White Mountains the first brood of butterflies usually appears from the sixteenth to the twentieth of June* and becomes abundant in four or five days; sometimes its appearance is considerably delayed, and the numbers increase by the advent of fresh specimens for about three weeks; the latest emergence of which I have exact date is July 18; by the middle of July the numbers perceptibly diminish, but it remains on the wing until early in August and a few dilapidated specimens, mostly males, may be found even to the middle of that month, possibly a few days later. After the first days of July, however, almost no perfect specimens can be found, for the wings of fresh specimens become torn and ragged in a very few days, although their colors may be undimmed. There is no evidence that the butterfly appears any earlier in the more southern localities where it is found than in the White Mountains. Indeed we have no record of its capture in Massachusetts previous to the very end of June, but that it is indigenous and has not flown there from the north is shown at once by its commonly larger size. Edwards states that it appears in the Catskills "about the end of June." I have found it in such plenty in the Greylock Hopper on the last of June that it must have been out for at least a week, and I have no doubt that its actual appearance in a given year is at least as early in the south as in the north, though these statistics look strangely the other way.

How early preparations are made for another brood my own observations do not show. Edwards states that the eggs are laid in the Catskills the last of July and early in August. He does not definitely state that they are not laid earlier but one would infer it. My failure to keep exact note of the time I have found the caterpillar does not enable me to verify or deny this as the case in the White Mountains, but from my mere recollection of the case I am strongly inclined to believe that the butterfly begins to lay eggs in the early part or at least the middle of July, and that eggs are laid from this time until the end of the month, very rarely in August, perhaps never after its first week. The eggs hatch in about a week, and the caterpillar may therefore be found in its first stage between mid July and mid August. As the caterpillar is at first a slow feeder and a slow grower, those which are latest may sometimes be cut off by early and severe frosts; others, and probably the mass of them, reach their second or third stage before the approach of winter; in the White Mountains they begin to make their hibernacula by the middle of August, and can rarely if ever be found feeding, except for such preparation, after the 25th of that month. Others again, the earliest out, may in a favorable season, *and in considerable numbers*,—and it is here that Mr. Edwards does not agree with me—

*Specimens raised in West Virginia from autumn gave the butterfly at the end of the caterpillars transported there the previous following April.

reach their third stage in midsummer and so pass on to chrysalis and to a second or supplementary brood of butterflies, which makes its appearance late in August, probably never before the 20th, and becomes fairly abundant by the first of September. This is in no way so numerous as the first brood, and disappears by the middle of the month. On account of its late appearance it is probable that the greater part of, possibly all, the caterpillars from this brood of butterflies—if indeed they lay eggs at all—perish before they are old enough to construct hibernacula; but that there is such a brood—though it seems to have been observed by only a few persons—can hardly be fairly questioned. My own observations are so old and indefinite that I would not rely upon them if they were not supported by independent testimony; I only know that I have met with numerous fresh specimens at the time stated. Packard in his "Guide" says the butterflies fly in June and "again late in August." Dr. J. C. Merrill one year reported to me that he found the butterfly at the White Mountains on "September 1 in abundance and fine condition," Gosse reports taking one specimen at Sherbrooke, Canada, on September 4, Professor S. I. Smith found "several on September 8th" at Norway, Maine, and Mr. F. H. Sprague has taken "new" specimens both male and female at South Hadley, Massachusetts, on August 7, and at Deerfield, Massachusetts, August 17.

Without great latitude none of these can be looked on as belonging to the July brood of butterflies, for there is scarcely a butterfly known to me which is so quickly damaged, a perfect specimen more than three days out of chrysalis being a rarity. Fresh butterflies in Massachusetts in the second and third weeks of August, and any butterflies at all in the White Mountain region toward the end of the first week in September—not to specify abundant fresh ones at the beginning of the month—are certainly from eggs of the same year and not from those laid at least a twelve-month before. This is the more probable since it is at this time that the second brood of its congeners are flying and laying eggs in New England, species which pass the winter in precisely the same condition and at the very same age. But in the present case the late August butterflies should be looked upon rather as an attempt toward a second brood than a regularly recurring event, since they have failed to meet the notice of so many observers who would be likely to meet with them.

Habits, flight, etc. This is one of our handsomest butterflies, its broad white bow forming a striking contrast to the deep ground color of the wings as it flits over the moist forest road. It is very active and has a rather short and rapid flight. "When it alights on a tree," says Mr. Lintner, "it seldom remains stationary, but continues walking over the leaves, spreading and folding its wings." Mr. Jones says that "it appears to frequent the upper branches of hard-wood trees, where it

delights to rest and bask in the noonday sun"; Gosse mentions seeing "as many as sixteen of this species crowded together on an old log by the roadside, so close together as to be almost touching in every part." Mr. Emery found them associating with the marsh-loving *Euphydryas*, probably the result of their partiality for moisture; they may always be found in companies on the moist ground about the water troughs placed by the roadside in the hilly country, and they start almost from beneath one's feet in the gloomiest part of the damp forest road, where, if one but wait patiently, the startled beauties will reassemble and the choicest may be readily captured.

"When alarmed," says Edwards, "it darts swiftly away and courses up and down the path, or flies into the trees, but will soon return. . . . It flies at some distance from the forest also, and visits orchards for the rotten apples, and farm houses for the chance of what it may find to its liking." It is very fond of all excrement or other moisture. Edwards tells us how its body becomes distended when fed in a vivarium on sweetened fluids, and Jack relates how it will feed on the sweets exuded from the caruncles of plant lice. D'Urban found it "very restless and active when on the ground, constantly opening and shutting its wings, unrolling its tongue, and running to and fro very rapidly, and even when feeding is not easily surprised. It flies freely in cloudy weather and quite late in the afternoon." Although, as Jones says, it sometimes mounts to the tops of the highest trees, it usually flies only two or three feet above the ground, along the road, sailing on its broad wings rather than flying, or if not sailing, moving slowly with a rapid but very short flutter. It is very social in its nature, as the statements given above of its abundance show. Alighted together they are nearly always still very active, changing their position constantly and crowding against one another, so that their wings are soon abraded.

When fairly at rest in such a position, the wings are closed back to back, the fore wings so far advanced as to leave two of the smaller subapical white spots visible beyond the margin of the hind wing; the body is raised at an angle of 45° with the ground; the antennae are straight except for a basal arch when seen from the side, parallel to the body, and divaricate at an angle of 90° .

Dimorphism. This species is looked upon by Edwards as dimorphic, the alternative form being known as *proserpina*. My reasons for thinking otherwise have been given separately under the head of the latter form, where I regard it as a hybrid between *B. ursula* and *B. arthemis*.

Mimicry. The only evidence of mimicry in this species is in the early stages. In common with the other species, both larva and pupa resemble the dropping of birds. I have already related that an unknown notodontian feeds upon black birch in the same manner and stations as

arthemis. Whether it avails either of them as a copy of the other can hardly be told; certainly we have no evidence of it; but the hibernaculum has a remarkable resemblance to the bursting buds and curving terminal shoots of the birch in spring (81:5), which may not unlikely prove protective at the season when if ever certain kinds of hymenopterous parasites would attack it; the color, too, of the soft down of the buds and the enveloping silk and dried shell of the hibernacula is as similar as are their forms.

Enemies. No parasite has ever been obtained from this species, but I have observed an evil-looking Ichneumon wandering about the bursting leaves of the black birch, apparently hunting like myself for the caterpillar. And I have also seen some signs of violence to the hibernacula. In one instance in particular, a caterpillar which constructed its winter abode on a little birch growing under a wire enclosure in my garden, and had lived there for ten days where no bird could reach it, was found about September 10 to have disappeared and its hibernaculum ripped open — probably by some wasp which coveted it.

Desiderata. The principal unsettled points of interest in this butterfly are its precise relations to the form *proserpina* and its history in the latter part of summer; field observations on the abundance and exact condition, sex, and, if female, the development of the eggs within the body, of all August and September specimens are needed; besides this, further investigation should be directed to the age of the female at first oviposition, and how long she continues laying eggs; whether basswood, thorn, shadbush, honeysuckle and elm are food plants of the larva by choice or by necessity; what parasites there are; what advantage there may be to the notodontian that feeds on the birch in so similar a manner; and what the western and northern limits of the distribution of our species may be.

LIST OF ILLUSTRATIONS.—*BASILARCHIA ARTHEMIS*.

<i>Egg.</i>		<i>Chrysalis.</i>	
Pl. 54, fig. 15. Colored.		Pl. 83, fig. 14. Side view, colored.	
67:5. Micropyle.		23. Dorsal view, outline.	
<i>Caterpillar.</i>		<i>Imago.</i>	
Pl. 74, fig. 26. Side view, colored.		Pl. 2, fig. 5. Male, both surfaces.	
78:21-23. Front view of head, stages i-iii.		33:9. Male abdominal appendages.	
24. Front view of head, fifth stage.		38:9. Neuration.	
81:5. Hibernaculum, and spring bud of birch.		<i>General.</i>	
		Pl. 19, fig. 5. Distribution in North America.	

TRIBE VANESSIDI.

ANGLE WINGS.

Vanessidi Steph.; Vanessidae Dup.; Vanessides Kirb.; Vanessoides Koch.

Papiliones angulati Wien. Verz.
Praefecti Herbst.

Amongst these leaves she made a Butterflie,
With excellent device and wondrous slight,
Fluttering among the olives wantonly,
That seem'd to live, so like it was in sight:
The velvet nap which on his wings doth lie,
The silken downe with which his back is dight,
His broad outstretched hornes, his hayrie thies,
His glorious colours, and his glistering eies.

SPENSER.—*Muiopotmos*.

Imago. Head: club of antennae rather long, but pretty distinctly marked, cylindrical or a little depressed, with three inferior carinations. Palpi stout with a coarse, heavy mass of scales and hairs, the terminal joint comparatively long, usually about one-third the length of the middle joint.

Thorax: first and second superior subcostal nervules of the fore wing arising before the tip of the cell; the third and fourth beyond; cell open or closed; the median nervure connected beyond its second divarication with the vein closing the cell, when the cell is not open. Precostal nervure of hind wings originating beyond the divarication of the subcostal from the costal. Cell open or closed. Tibiae and tarsi destitute of spines above, but the upper portion of the inner surface of the tibiae with a single row of them; two rows of spines on the under surface of the terminal tarsal joint (excepting Vanessa), the inner rows being absent; fore tarsi of the female consisting of five joints, provided only with spurs, the last joint with a pair like the others.

Abdomen of male with all the appendages closely concealed by the terminal segment; in proportion to the body they are unusually small, so that it is often difficult to distinguish the sexes by them without considerable denudation, especially as the abdomen of the male is often as plump as that of the female. Upper organ very small, bearing a single, usually rather inconspicuous, central hook and inferior arms, which meet below the anus and are often considerably developed. Clasps proportionally very large, generally much broader than long, the upper process either basal, long, slender, and curving so as to appear at first glance like the upper hook or as an appendage to it; or wholly wanting and replaced by the unusual development of the inferior arms of the upper organ; interior finger similar to that of Nymphalidi, but seldom surpassing the upper edge.

Egg. Compact, taller than broad, with comparatively few, very prominent, sharp, longitudinal ridges, highest on the summit.

Caterpillar at birth. Papillae of body inconspicuous, equal, arranged in a different manner on the thoracic and abdominal segments, the hairs exceedingly long, slender, tapering and finely pointed.

Mature caterpillar. Head much smaller than the middle of the body, usually tumid on either side above, sometimes crowned by a compound spine. Body tapering forward considerably on the thoracic segments; segments divided into four transverse sections, of which the anterior is as large as the other three together, the hindmost sometimes obscure; armed with spines which are compact, thorn-like, tapering, with diverging needles mounted on spinules, directed angularly upward; they are distributed regularly over the body, a dorsal row on the abdominal segments and two other rows on either side above the spiracles, extending over the whole body; on the first thoracic segment only a transverse series of papilliform tubercles.

Chrysalis. Head projecting beyond and distinct from the thorax. Superior border of the wings with a secondary tubercle about as prominent as the basal one, situated directly below the highest point of the mesothorax; dorsum of mesothorax carinate

and elevated to a very prominent compressed tubercle behind the middle. Dorsum of abdomen not carinate, but with a dorsal row of very large, sharp, conical tubercles, those of the fourth segment usually the largest; cremaster long, rather slender tapering.

The butterflies composing this group are commonly of the medium, or a little above the medium size; and are among the showiest and best known insects in the temperate zone, or the regions where entomology has been most cultivated. The wings are decidedly angular and excised, with a considerable costal curve in the fore wings; they vary considerably in design and color, but are generally very dark with fulvous markings, or the reverse, upon the upper side; the under surface, especially of the hind wings, is generally marbled with shades of brown, or irrorate with transverse threads of alternating darker and paler colors; sometimes they are ornamented with ocellated spots which often assume the brilliant shades of peacock's plumes; often there is a very small, central, silvery mark on the hind wing.

The insects are found almost equally in both hemispheres, and, relatively speaking, find their maximum of development in the temperate zones, although some of the genera are richly endowed in the hotter regions of the Old World. They are of an audacious nature, with a bold, vigorous and capricious flight.

The eggs are rather tall, ovate, broader below than above, and furnished with a limited number of very prominent longitudinal ribs, most elevated above; they are laid either singly or in masses, and the caterpillars are accordingly solitary or gregarious; if gregarious, retaining this habit throughout the larval existence, or, again, changing when half grown; while associated, they spin for themselves a common web, and even the solitary species often weave nests, though more of leaves than web. The caterpillars may be readily distinguished by their invariably cylindrical body, covered with a regular series of spinous thorns of equal or nearly equal length, beset with bristles, even the head being oftentimes crowned by a similar pair; the rows of spines on the thoracic and abdominal segments are not continuous. The pupae are strongly angulated and tuberculated, more so than those of any other butterfly;* and from the golden or opaline spots that frequently ornament the conical tubercles, and sometimes, especially in parasitized specimens, the whole body, have won for this condition of all butterflies the fanciful name of chrysalids.

These insects are usually at least double-brooded and ordinarily hibernate in the imago state (in woodpiles and old buildings, under stones and beneath the limbs of trees), although in some species the chrysalis also survives the winter. The butterflies that hibernate do not mate until spring, to judge from numerous observations both in this country and in Europe.

* An unknown Cuban species in the Cambridge museum has a forked spine on the back.

Six of the few fossil butterflies known belong to this tribe, or more than one-third of the whole number; of these five were found at Florissant, Col., and belong to as many extinct genera, distantly related to *Junonia*; the remaining species comes from Croatia and belongs to the genus *Eugonia*, and is indeed very closely related to our species.

Table of genera of Vanessidi, based on the egg.

Eggs deposited side by side in layers.

Egg higher than broad, with eight or less vertical ribs, and laid around a twig.

Ribs decidedly higher on summit than on sides.....**Eugonia**

Ribs only a very little higher on summit than on sides.....**Euvanessa**.

Egg of equal height and breadth, with at least nine vertical ribs, and laid on the surface of a leaf.....**Aglais**.

Eggs deposited singly or in chains one above another.

Free space at summit of egg half the diameter of base.....**Junonia**.

Free space at summit much less than half the diameter of base.

Egg, including vertical ribs, distinctly narrower at middle of upper third than at broadest, the whole upper half gradually narrowing, the body of the egg much less shouldered above than in *Vanessa*.....**Polygonia**.

Egg, including vertical ribs, hardly narrower at middle of upper third than at broadest, the body of the egg distinctly though roundly 'shouldered above.....**Vanessa**.

Table of genera, based on the caterpillar at birth.

A pair of bristles beneath the abdominal spiracles.....**Polygonia**.

A single bristle beneath the abdominal spiracles.

Subdorsal bristles of abdominal segments barely in advance of the middle of the segments.

Infrastigmatal bristles of abdominal segments directly beneath the spiracles.....

Euvanessa.

Infrastigmatal bristles of abdominal segments distinctly in advance of the spiracles...

Aglais.

Subdorsal abdominal bristles in the middle of the anterior half of the segments...**Vanessa**.

(*Eugonia* and *Junonia* not seen).

Table of genera, based on the mature caterpillar.

Head crowned with prominent spines.

Spinules of body spines arranged in a stellate manner**Polygonia**.

Spinules of body spines not arranged in a stellate manner.

Spines of thoracic segments bearing no spinules on basal half.....**Eugonia**.

Spines of thoracic segments furnished with spinules throughout.....**Junonia**.

Head destitute of conspicuous spines.

Second abdominal segment without a mediodorsal spine.....**Euvanessa**.

Second abdominal segment with a mediodorsal spine.

No mediodorsal spine on first abdominal segment.....**Aglais**.

A mediodorsal spine on first abdominal segment**Vanessa**.

Table of genera, based on the chrysalis.

Ocellar tubercles developed as pointed processes.

A small anterior mediodorsal tubercle on second abdominal segment.

Mesothoracic tubercle large and very prominent, compressed-laminate, at least at tip.

A minute but distinct suprastigmatal tubercle on eighth abdominal segment.....

Polygonia.

Suprastigmatal tubercle on eighth abdominal segment scarcely perceptible or obsolete.....

Mesothoracic tubercle moderate, almost uniformly tectate, the apex pyramidal.**Aglais**.

No mediodorsal tubercle on second abdominal segment**Euvanessa**.

Ocellar tubercles blunt, scarcely produced.

Alar ridge sharply carinate, the dentations pointed.....**Vanessa**.

Alar ridge bluntly carinate, the dentations inconspicuous and rounded.....**Junonia**.

Table of genera, based on the imago.

- Fore wings sharply angulated in the lowest subcostal interspace.
 Basal three-fifths of hind wings more or less spotted with black above; centre of hind wings with a white or silvery comma beneath.
 Inner border on fore wings roundly excised beyond the middle.....**Polygonia**.
 Inner border of fore wings straight.....**Eugonia**.
 Basal three-fifths of hind wings uniformly dark; no silvery spot beneath.
 Wings with a lighter marginal band above; hind wings with numerous straight, spinous hairs beneath.....**Euvanessa**.
 Wings with a lighter submarginal band; hind wings without spinous hairs on under surface.....**Aglais**.
 Fore wings produced, but rounded in the lowest subcostal interspace.
 Eyes pilose; upper surface of fore wings without conspicuous eye-like spots....**Vanessa**.
 Eyes naked; upper surface of all the wings with conspicuous eye-like spots**Junonia**.

SECTION I.

Wings of imago strongly angulated; hook of upper organ of abdominal appendages small and inconspicuous; inferior arms not greatly developed; clasps much broader than long, the upper process present. Chrysalis much more strongly angulated than in the succeeding group, the tubercles sharply pointed.

GENERA: **Polygonia**, **Eugonia**, **Euvanessa**, **Aglais**.

POLYGONIA HÜBNER.

Polygonia Hübn., Verz. bek. schmett., 26 (1816). Grapta Kirb., Faun. bor. amer., iv: 292 (1837).
Comma Renn., Conspectus, 8 (1832). *Vanessa* (pars) Auct.

Type.—*Pap. c-album* Linn.

For he so swift and nimble was of flight,
 That from this lower tract he dar'd to stie
 Up to the clowdes, and thence with pineons light
 To mount aloft unto the cristall skie,
 To view the workmanship of heavens hight:
 Whence down descending he along would flie
 Upon the streaming rivers, sport to finde;
 And oft would dare to tempt the troublous winde.

SPENSER.—*Muiopotmos*.

Imago (52:8). Head of moderate size, pretty densely clothed with longer and shorter hairs. Front moderately swollen, slightly fuller beneath, broader than high, a very little broader than the eyes; upper edge projecting in the middle as a broad, rounded triangle, terminating abruptly; lower edge broadly rounded. Vertex moderately large, somewhat tumid, rising, throughout, above the upper level of the eyes, its anterior edge produced between the antennae by a considerable and swollen protuberance which falls rather suddenly, its posterior edge nearly straight, the outer posterior angles well rounded off. Eyes not large, pretty full, pilose with pretty long hairs, longest in the middle of the upper half, in front. Antennae inserted in the middle of the summit in deep, spacious, nearly connected pits, their interior bases separated by a space equal to nearly twice the width of the antennal stalk, their exterior close to the margin of the eyes; nearly twice as long as the abdomen, composed of 38-41 joints, the last ten or eleven of which form an elongated somewhat ovate club, strongly compressed, increasing very gradually in size, the last three joints only entering into the diminution of size, the tip very bluntly conical; the club is about four times as broad as the stalk and between four and five times as long as broad, furnished beneath with a slight, longitudinal, treble carina, passing down upon the stalk. Palpi pretty stout, nearly three times as long as the eye, a little compressed, curved slightly forward, the terminal about one-third the length of the middle joint, the whole heavily

clothed throughout with long erect scales, particularly long upon the upper surface of the outer half of the middle joint, at the tip of which they overarch and are separate from those of the terminal joint; middle joint furnished above and below with a few very long and delicate hairs, the whole generally directed in a vertical plane.

Prothoracic lobes pretty large, tumid, the ends well rounded and of nearly uniform size, broadly rounded above, scarcely four times as broad as long and fully as long as high. Patagia scarcely twice as long as broad, rather small, well rounded and nearly circular at the base, scarcely tumid, the posterior lobe slender, tapering, scarcely curved and rather sharply pointed, the outer edge straight.

Fore wings (38:10) considerably more than half as long again as broad, the costal border pretty regularly and somewhat considerably bowed, the middle half nearly straight, slightly excised near the base. Outer border very irregular, the portion above the middle of the lower subcostal interspace straight or slightly concave, directed at an angle of about 115° with the apical portion of the costal margin, the angle scarcely rounded; from this point it suddenly recedes and passes in a strong, more or less crenulate curve, more rapid above than below, to just below the tip of the lowest median nervule, where a second tooth is formed, much less conspicuous than the upper and sometimes very slight; inner margin greatly sinuate, the basal half being regularly and little convex, the apical half regularly and considerably concave, the outer angle rather broadly rounded off. First superior subcostal nervule emitted a little beyond the middle of the outer two-thirds of the upper margin of the cell; the second at about midway between the origin of the first and the tip of the cell; the third as far from the first as the fourth from the tip of the cell; the fourth at a little more than a third of the distance from the origin of the third to the tip of the wing; the second inferior subcostal nervule arises one-fourth way down the cell; the latter nearly half as long as the wing and nearly three times as long as broad. The middle of the basal curve of the last median nervule connected with the vein closing the cell.

Hind wings with the costal margin a little swollen at the base, beyond slightly and broadly sinuous; the outer border more or less regularly crenulate or rounded produced at the nervule tips, more considerably at the tip of the upper subcostal and especially of the upper median nervule, in the last case produced to a greater or less extent as a rounded tipped tail; the upper half of the wing, between the two larger prominences having a broad and slight concavity, the lower half having a general straight, sometimes slightly concave course, at a general angle of about 135° with the upper portion; upper extremity of outer border a little excised; lower extremity slightly produced and rounded, the general direction of the apical part of the inner border being at a right angle or a little less with the outer border; inner border suddenly and considerably produced at the base, beyond straight more than half way to the tip, when it suddenly recedes and proceeds parallel to its first course. Precostal nervure bent outward, originating somewhat beyond the divarication of the costal and subcostal nervures. Cell closed by a very feeble vein.

Fore legs small, cylindrical, clothed on either side with a spreading brush of hairs, much more thick in the male than in the female; tibia fully half the length of the hind tibia; tarsi nearly as long as the tibia, especially in the female; consisting either of a single uniform joint with the faintest possible mark of division into sections (δ); or of five joints, the last four about equal, the first more than twice as long as the others together (φ), all armed beneath at the tip with a pair of very delicate and minute spines, the outer joints devoid of scales between them. Middle tibiae slightly longer than the hinder, furnished on either side beneath and on the upper portion of the inner side with a row of rather infrequent, long and slender, slightly spreading spines, the terminal ones of the inferior rows produced to scarcely longer delicate spurs. Tarsi with the first joint equal to the second, third and fourth taken together, which decrease in length in the order mentioned, the second less than twice as long as the fourth, and scarcely so long as the fifth; joints furnished beneath with four, the last with two rows of rather short and moderately slender spines, the terminal ones of each

joint slightly longer than the others. Claws very small and delicate, tapering to a delicate point, not strongly curved; paronychial bifid, one blade needle like, scarcely curved, fully as long as the claw, very delicate and tapering; the other not half so long, coarser but tapering and curving toward the other; pulvillus wanting.

Abdomen compressed, fusiform, compact, the upper organ of the male appendages very inconspicuous; hook small, simple, no longer than the body, tapering and but little arched. Claspers small, about twice as broad as long, subquadrate, the upper outer angle more or less produced as an incurving lobe, the basal process of the upper edge long and slender, depressed, tapering, bent over so that those of the opposite sides often cross and at the same time are directed backward so as to simulate the hook of the upper organ; interior finger long and slender, directed upward traversing the middle of the clasp, smooth, hugging the clasp and seldom surpassing it.

Egg. Of much the general shape of that of *Eu Vanessa*; taller than broad, broadest near the base, tapering upward with a slightly swelling curve, the summit broad and nearly flat; furnished with a few regular, straight, equidistant, compressed, prominent, longitudinal ribs, which increase in height as they approach the summit, being most elevated as they cross its border; they extend a little way over the summit, terminating rather abruptly; surface between the ribs smooth, broken up into cells by delicate cross lines.

Caterpillar at birth. Head smooth, not spined, with a few long curving hairs. Body uniform, the first thoracic segment with a transverse corneous plate, the others with transverse ridges on the anterior portion, on which are seated minute warts, each giving rise to a long hair; these warts are arranged on either side in a subdorsal row (becoming laterodorsal on the thoracic segments) placed a little in advance of the middle, a supralateral row placed posteriorly, a laterostigmatal row beneath the subdorsal, and a stigmatal row posteriorly, one to a segment in each row; and also a pair of infrastigmatal bristles just in advance of the middle of each segment.

Mature caterpillar. Head rather small, subquadrate on a front view, the sides scarcely tumid, the summit slightly depressed in the middle, a little full in the ocellar region, scarcely deeper below than above, rather broader than high; the triangle half as high again as broad, reaching more than half way toward the summit; head a little swollen at the upper outer portion of each hemisphere and produced, bearing a stout long spine, directed upward, a little outward and slightly forward, encircled in the middle by a stellate arrangement of five spreading, upturned, elongated, stout, smooth, tapering spinules, bluntly rounded at tip like the main spine, and unlike it, bearing at the extremity a pretty long fine hair. The head is also beset with numerous elongated, cylindric but slightly tapering, smooth tubercles, bluntly rounded at tip and emitting a pretty long delicate hair; those near the hinder edge are longer than the others, and a similar one is found just in front of and a little within the summit spine, and a still larger one in the middle of each hemisphere. Antennae having the basal joint not very large, hemispherical, second and third cylindrical, of equal diameter, the second half as long as broad, the third nearly three times as long as broad, emitting a delicate hair several times longer than itself and bearing on the inner side a minute fourth joint scarcely visible. Ocelli six in number, five arranged in a broad curve whose convexity is forward, the second, third and fourth counting from above closely crowded, with scarcely any space between them; the first is separated from the second by its own diameter and the fifth from the fourth by nearly twice as much; the sixth is nearly in, but a little in advance of, the centre of the circle upon the circumference of which the others are seated; the first and sixth are inconspicuous, slightly elevated; the others are very prominent, higher than their own diameter, the summits hemispherical, the sides straight; the diameter of all is about equal. Labrum small, deeply and abruptly cleft in the middle so as almost to appear to be made of two halves, which are longer than broad and have their outer sides well rounded. Mandibles very small, as broad as long, the edge square and smooth. Maxillary palpi four-jointed, the first and second joints of equal diameter, the first very short, the second nearly as long as broad, the third not half its diameter but nearly half as long

again as broad, tapering very slightly, the tip rounded; fourth minute but not inconspicuous. Spinnerets slender, delicate, finely pointed.

Body cylindrical, the first thoracic joint small, the segments more than usually moniliform, the first thoracic segment furnished in the middle with a transverse row of six elongated, smooth and slender tubercles situated on the dorsal region and each giving rise to a long hair; and below the spiracles with two similar ones on either side; the other segments are furnished with compound spines, each seated on a broad, low, mammiform, fleshy elevation and consisting of a long and slender, tapering, often not quite straight spine, squarely docked at the slender tip, and bearing as a continuation a not very long, tapering, spinous bristle, whose base is nearly or quite as large as the tip of the spine. The latter is further provided near the middle with five spreading straight spinules, arranged in a stellate manner but not originating at exactly equal heights, elevated so as to form less than a right angle with the upper part of the spine and in all its general features resembling it. Below this coronet the spine often bears a number of usually smaller similar spinules also emitting hairs and irregularly disposed; below the coronet the main spine generally tapers more rapidly and is more irregular than above it. These spines are erect, perpendicular to the body, and are arranged in the following series, one upon a segment in each row: upon the anterior portion of the first to eighth abdominal segments a dorsal row; from the second thoracic to the eighth abdominal segments inclusive a laterodorsal series, placed centrally or slightly in advance of the centre; from the second thoracic to the ninth abdominal segments inclusive a laterostigmatal series, the last segment bearing two, one anteriorly and the other posteriorly, while those of the other segments are situated as in the laterodorsal series; from the first to the eighth abdominal segments an infrastigmatal series of smaller spines placed centrally. At the base of the legs and prolegs and in similar situation on the segments between them are one or two elongated, smooth, slender tubercles like those of the first thoracic segment. Spiracles rather small, obovate, about twice as long as broad. Legs moderately long, slender, tapering, compressed; the claw small, slender, compressed, but little curved, strongly heeled at the base beneath. Prolegs very long, pretty large, tapering pretty regularly and considerably, the hooklets very slender, pretty long, scarcely tapering, strongly curved, closely crowded, from twenty to twenty-five in number, arranged in a double row around two-thirds of a compressed circle, opening outwards.

The thoracic spines of the laterodorsal and laterostigmatal series are placed slightly lower than the corresponding spines of the abdomen, but I have not thought the difference sufficient to distinguish them as separate rows.

Chrysalis. Viewed from above the head and prothorax scarcely taper; ocellar prominences directed straight forward, prominent, conical or nearly so, tapering either in the apical half or throughout, the space between them squarely docked; on a side view they are straight and horizontal or nearly so on the inferior border, either continuous with the anterior half of the body and minutely protuberant at their base, or directed slightly upward from their base; upper border straight and continuous with the line of the dorsum to the front part of the mesonotum, being at an angle of from 40° to 50° with the inferior surface; a slight ridge runs from both of them toward the centre of the mesonotum but disappears on the anterior portion of that segment. The mesonotum is high, well arched and bears upon its middle third an exceedingly high, compressed, laminate, median projection, most elevated posteriorly, where it is sometimes pointed, behind nearly perpendicular, in front well rounded or arched or almost hunched; the form of this mesonotal tubercle differs considerably in the different species and is quite constant in the same species; the front, including all the appendages, forming an almost exactly straight line from the base of the head to the extremity of the wings, a little protuberant just before the tip of the latter; the middle of the mesonotum is also furnished with a pair of small, blunt, conical, slightly appressed, supralateral warts, nearly connected with the basal wing tubercle by a slight ridge; basal wings tubercle pyramidal, triquetral, half as high as broad, pointed, one angle running backward, one downward and one upward, the latter continued as a

ridge nearly meeting that of the supralateral tubercle above it and at its upper extremity slightly elevated; supernumerary wing tubercle pretty strongly compressed with a rather sharp ridge, its highest point bluntly rounded and rather more prominent than the basal tubercle, falling off rapidly behind. Wings also considerably protuberant near the posterior border in the middle of the upper half and elevated into a blunt conical tubercle. Metanotum with a pair of small, conical, supralateral, central warts; joints of the legs and antennae thickened a little centrally at the incisure. Abdomen separated from the thorax by a very deep incision; its dorsum very much arched longitudinally, provided with a dorsal series of low, small, conical warts on the anterior edges of the second to eighth segments; a series of more or less elevated, conical, usually pointed, slightly forward and outward directed, laterodorsal tubercles on the centre of the second to seventh segments, largest on the fourth; the eighth also sometimes with a scarcely elevated rounded wart at the same point, and the first segment with a slight conical wart similarly placed but on the anterior edge of the segment; a series of small, bluntly rounded, suprastigmatal warts, placed a little in advance of the middle of the second to seventh segments. Preanal button formed of a pair of stout, rounded but well raised, coarsely punctured, longitudinal, subdorsal ridges, slightly curved, almost equally approximate at either end, each terminating in a blunt short tubercle. Cremaster viewed from above very long and slender, tapering a little, twice as long as its medium breadth, rather broadly and deeply channeled as far as the terminal ridge; viewed laterally it is equal, a little enlarged at the very tip, slightly curved; the apical field of hooklets nearly circular, a little produced at the anterior outer surface. Anal hooklets not very long, moderately slender, the basal half straight and equal, the apical half enlarging somewhat but not greatly, curved into something like a semicircle, the apex bent a little more and directed toward the base, the tip bluntly pointed.

The butterflies of this genus are spread over nearly the whole north temperate zone, but their metropolis is unquestionably North America.* Only three species distinct from American forms are known to occur in the Old World and these are all representatives of North American species; one of them is confined to southern Europe and western Asia; a second occurs further south in China; while the third extends from ocean to ocean. One more species, which has been identified with our *progne*, but which will more likely prove to be its representative *zephyrus* Edw., has been found in the extreme north east of Siberia. In North America, on the other hand, we find no less than six species east of the Rocky Mountains, while on the western coast and in the Rocky Mountain region itself, where some of these also are found, several other reputed species occur, and perhaps others await recognition; still two other species are recorded from Mexico. Two of the species of this genus are much larger than the others and occupy more southern stations, one in China, the other in the United States, especially in the South. The American species occurring east of the Rocky Mountains are all, with possibly one exception, found within the limits of New England; one of them, the largest, has the most extensive range in the settled parts of the country, being common not only to the southern states of the Union but also to the Alleghanian fauna and occurring occasionally in the Canada district; a second is characteristic of the

* It is evidently by an oversight that Kirby (Journ. Royal Dubl. soc., v: 170,) deprives

America of her share of the genus, for at a previous page he speaks of one of our species.

Canadian fauna, but extends north to a great distance, being found through the whole interior of the continent from ocean to ocean. Another probably has nearly as extensive a range, but has only been found at a few points within it; two others belong properly to the Alleghanian fauna, though one extends further north and not so far south as the other; a sixth is a Pacific coast species found once or twice near our northern borders; nearly all these forms meet in central New England, and but one other genus of butterflies is better endowed with New England species.

Among our native *Nymphalidae* the butterflies of this genus may be known almost at a glance by their greatly angulated and excised wings. They are mostly of moderate size and above are all tawny colored, heavily spotted and broadly bordered, especially the hind wings, with black, and frequently edged with a gray bloom; the markings on the upper wings consist mainly of two bars depending from the costal margin, one at the tip of the cell, the other mid-way between it and the apex, and of a series of five or six spots arranged in a line bent at right angles, the limbs nearly equal, one crossing the middle of the basal half of the wing, the other extending across the lower interspaces toward the tip; the markings on the hind wing are composed principally of irregularly arranged blotches lying rather within the middle of the wing. Beneath, both wings are somewhat similarly marbled and irrorate with dark fuscous on a more or less ashy brown ground, the basal half darker and limited by a clearly defined, continuous, but very irregular border; there are one or more rows of small greenish or bluish spots, and near the middle of the outer half a sinuate and bent series of black dots, often enclosed in dark clouds which sometimes coalesce and form a band; the greater part of the wings is often suffused by a more or less glaucous bloom, and in addition there is a silvery mark like a comma or semicolon in the centre of the hind wings; these have also a short tail at the extremity of the upper median nervule. The characters drawn from the legs are in many respects erroneously given by Doubleday.

Most of the species are double-brooded, the butterflies appearing in July and sometimes in September, those of the last brood hibernating; the eggs hatch in four or five days, and the chrysalis state lasts from one to two weeks, although in the autumn brood sometimes prolonged to four. The eggs are laid singly (or occasionally in chains, one above the other), and the caterpillars are solitary. In leaving the egg, they do not devour it, but, as a correspondent of Mr. Edwards writes, they "scramble through their scuttles in hot haste, totally regardless as to who may take possession of their late tenements, leaving whole hamlets to prove their presence in the vicinity" (*Can. ent.*, xiv: 207). They feed almost exclusively on *Urticaceae* and *Grossulaceae*, and usually live on the under surfaces of the leaves, sometimes partially concealing themselves by drawing together with silken threads the outer edges. The butterflies have a quick, ner-

vous, irregular flight, so that Geoffroy named the common European species *Robert le Diable*; they are fond of the juices of fruit and the sap of trees, and are usually found by the roadside or on sunny spots in the vicinity of woods, alighting almost invariably on horizontal surfaces, in somewhat striking distinction from *Eugonia* and *Eu Vanessa*, which are fond of pitching erect on trunks of trees.

The fondness of the butterflies for the vicinity of forests makes it probable that they hibernate in the woods. Mr. Goossens in beating small trees over his open umbrella in the cold days of November, near Paris, twice brought down specimens of the European *P. c-album*, which fell with closed wings; apparently they must have chosen the under side of branches for hibernation, as has been seen in the case of other *Vanessidi*.

Most of our New England species, and some at least of the others, are dimorphic to a greater or less extent, the two forms generally differing in the extent or depth of the darker markings of the upper surface, and the stronger or weaker contrasts between the colors of the under surface. The dimorphic species, so far as known, are double brooded, and the others (at least in New England, i. e., *faunus* and *gracilis*) single brooded. The dimorphism is to a large extent—almost exclusively—seasonal, the first brood of butterflies being the darker, the autumn brood the lighter. The European *c-album* is double brooded, and varies so much that it should be deemed polymorphic, but no proper investigation of the relation of the different forms to each other has ever been made. Notwithstanding which, European entomologists of repute consider several of our species (which have been shown to differ unmistakably in structural features), to be identical with their own polymorphic form—a position which is utterly untenable. Mr. Edwards has discussed this point very fully in his *Butterflies of North America*. Mr. Mead suggests that the varieties of the European *c-album* are “nascent species,”—a stage which the American species, as older forms, have already past.

The egg is nearly spherical, but somewhat barrel shaped, and furnished with ten compressed, longitudinal ribs, which, on the upper half, greatly increase in height. The head of the young larva is smooth and the body furnished with six rows of minute warts, each emitting a long tapering hair. In the mature larva the head is crowned by a pair of long, stout, aculiferous spines; and the body bears seven longitudinal rows of mammi-form elevations, each surmounted by a spine beset with whorls of delicate bristles. The chrysalids are angular and tuberculated, the ocellar prominences more or less conical and pointed, and the dorsum of the thorax produced like a very strongly compressed, very prominent, subquadrate keel, sometimes shaped like a Roman nose.

EXCURSUS IX. — DIMORPHISM AND POLYMORPHISM.

Who loves not the gay butterfly, which flits
 Before him in the ardent noon array'd
 In crimson, azure, emerald, and gold;
 With more magnificence upon his wing—
 His little wing—than ever graced the robe
 Gorgeous of royalty, is like the kine
 That wanders mid the flowers that gem the mead,
 Unconscious of their beauty.

CARRINGTON.

AMONG the subjects of general philosophical interest which the study of animals during the Darwinian epoch has brought to notice, few have excited more attention and interest than the existence in a vast number of animals of two or more distinct forms in the same species. That this is very commonly true of the two sexes goes without saying; but besides this it often happens that one sex may appear under two distinct guises, or that alternate broods of the same animals may differ so much from each other as in many cases to deceive the most acute naturalist into the very reasonable belief that they are distinct species. Much attention has been given to this subject among the butterflies, and we have in our native species a considerable number of instances in illustration. A large proportion of them show, in some peculiarities of the scales of the male sex and their arrangement into special patches, a ready distinction from the opposite sex, which is to be compared with such characteristics among birds as the special plumage assumed by the cock in his comb, wattles, arching tail and spurs. But just as the cock frequently differs further from the hen in the character of the plumage covering the whole body, so there are a very large number of butterflies which also differ from the opposite sex in the general color or pattern of the upper or lower surface of the wings. Curiously enough, when we consider how very generally the under surface of the hind wing is variegated in butterflies, we rarely find in this place any distinction between the sexes. It is largely confined, at any rate with the butterflies of the temperate zone, to the massive coloring of the upper surface, and here, whenever one of the sexes departs from the typical coloring of the group to which it belongs, in order to assume a livery distinct from its mate, it is almost always the female, at least among our own butterflies, which is thus distinguished. We have indeed but a single example, that of *Cyaniris pseudargiolus*, in which the opposite is true.

But besides that form of dimorphism which simply intensifies the distinctions between the sexes, we have in some cases a double dimorphism, so to speak, which not only distinguishes one sex from the other, but divides the members of one of the sexes into two distinct groups, one of which more nearly resembles the male, while the other may depart widely from it. We find several such instances among the *Rhodoceridi*. There are cases,

such as *Eurymus*, familiar to every outdoor entomologist, wherein the female, instead of being of nearly the same color as the male with some distinctions in the marginal bands, is of so very pallid a hue as to strike the observer at once. The contrary is true as regards the female of *Jasoniades glaucus* and the male of *Cyaniris pseudargiolus*, in which, in certain parts of the country, a dark form of the sex with nearly uniform brown upper surface is to be found.

But dimorphism by no means stops here, for we have in some of our other butterflies quite as striking or even more striking peculiarities. Take for instance the case of *Polygonia interrogationis*. Here is an insect where there are two very distinct forms in each sex, and in each of which the sexes are readily distinguished by the coloration of the wings; they differ in the brightness and variegation of the lower surface of both wings, and the obscurity of the upper surface of the hind pair; that is to say, there are four sets of individuals, which may be separated quite as readily as most closely allied butterflies, and more so than a great many acknowledged species of the best studied faunas. Nor is this by any means the whole statement of the case; these two types, bred from eggs laid by the same parent, not only differ in the markings of the wings, but also in their form and in the structure of the genitalia; in fact, we have two sets, permanently distinct from each other, and to which we can only not apply the name of species, because we know them to have the same parent. Now butterflies seek their own kind for mating and nothing more is needed to establish these forms as good species, than that each should persistently seek its own mate. Indeed, one can hardly help surmising that they already do so to a considerable extent, and that this is an instance of an almost formed species, beyond which it is almost impossible to go without becoming one. Between this condition and that of some other species, in which the sexes do not differ and there is very little variation, there is almost every grade of difference, so that we may fairly imagine that we know one means by which species are originated. Here, perhaps, if anywhere among butterflies, we ought to suspect that physiological selection, the province of which is so well insisted upon by Romanes, is beginning to play its part in the formation or rather the differentiation of species; since besides the colorational marks which may enable the sexes to choose their mates with discrimination, we have the first steps toward those changes in the organs ancillary to generation which everywhere mark absolutely distinct forms, and are safeguards against admixture. The case of *Iphiclidides ajax* is even more striking; nor has the story half been told of the mutations and polymorphism of *Cyaniris pseudargiolus*; but since a new element is here brought to view, in which dimorphism is exhibited by alternate broods of the same insect, we refer the reader for further particulars to the section upon that subject.

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- Darwin, C. The descent of man, and selection in relation to sex. London, 2 vol., 1871.
(Cf. chap. xi.)
- Scudder, S. H. Antigeny, or sexual dimorphism in butterflies. Boston, 1877 (Proc. Amer. acad.).

Table of species of Polygonia, based on the egg.

- | | |
|---|-------------------------|
| Egg more than a fourth higher than broad..... | interrogationis. |
| Egg less than a fourth higher than broad. | |
| Egg of equal height and breadth..... | faunus. |
| Egg about one-fifth higher than broad. | |
| Vertical ribs eleven in number..... | comma. |
| Vertical ribs ten or less in number..... | progne. |
| (Gracilis and satyrus not seen). | |

Table of species, based on the caterpillar at birth.

- Papillae of body dark but not black.
 Papillae brownish fuscous.....interrogationis.
 Papillae dark green.....faunus.
- Papillae of body black.
 Body varying from pale straw to dark green, the anterior margin of the segments livid....
 comma.
 Body grass green, the anterior margin of the segments very pale green.....progne.
 (Gracilis and satyrus not seen).

Table of species, based on the mature caterpillar.

- Upper surface uniformly variegated throughout.
- Lateral spinules emitted from below the middle of the coronal head-spines. **interrogationis.**
- Lateral spinules emitted from the middle of the coronal spines.
- Coronal spines stout, the lateral spinules coarse and about as long as the central spine beyond the circlet.....**comma.**
- Coronal spines slender, the lateral spinules slender but not so long as the central spine beyond the circlet.....**progne.**
- Dorsum of most of the abdominal segments white, in striking contrast to the sides.
- White dorsal patch extending over all the abdominal and some of the thoracic segments..**satyrus.**
- White dorsal patch not extending in advance of the second abdominal segment..**faunus.**
- (Gracilis not seen).

Table of species, based on the chrysalis.

- Ocellar prominences conical throughout; laterodorsal tubercles of fourth abdominal segment strikingly larger than the others.
- Mesonotal tubercle quadrate.
- Laterodorsal tubercles of fifth to seventh abdominal segments subequal..... **interrogationis.**
- Laterodorsal tubercles of fifth to seventh abdominal segments decreasing in size regularly and considerably..... **satyrus.**
- Mesonotal tubercle triangular..... **comma.**
- Ocellar prominences equal on basal half; laterodorsal tubercles of fourth abdominal segment not very much larger than the others.
- Notch between ocellar prominences deeper than broad..... **faunus.**
- Notch between ocellar prominences broader than deep..... **progne.**
- (*Gracilis* not seen).

Table of species, based on the imago.

Larger species. Under surface of hind wings with a central silvery semicolon; basal quarter of costal border of under surface of fore wings conspicuously mottled with pale yellow and brown.....**interrogationis**.

Smaller species. Under surface of hind wings with a central silvery comma or bent bar; basal quarter of costal border of fore wings beneath transversely streaked with brown and pale, not strongly contrasted with the surrounding parts.

The silvery comma expanded at the ends.

Variegated with wood-brown on the outer third of the wings beneath, all the green confined to the region beyond the cell of the hind wings; median portion of the outer border of fore wings gently crenulated.

Lower median basal spot on upper surface of fore wings small or obsolescent; hind wings with a border above at least twice as wide as that of fore wings....

comma.

Lower median basal spot on upper surface of fore wings large and distinct; hind wings with a narrow border above similar to but fainter than that of the fore wings.....**satyrus**.

Variegated with green on the outer third of the wings beneath; median portion of the outer border of the fore wings conspicuously crenulated.....**faunus**.

The silvery comma tapering or equal at the ends.

Hind wings beneath whitish hoary just beyond the middle, in vivid contrast to the base; upper limb of the comma blunt at tip.....**gracilis**.

Hind wings beneath but little paler beyond the middle than on the basal half; upper limb of the comma pointed at the tip.....**progne**.

GROUP I (interrogationis).

Antennae usually with 41 joints (satyrus 38); subcostal dentation of margin of hind wings only moderately prominent. Eggs generally laid in chains of three or four on the under surface of leaves. Markings of caterpillars generally formed of more or less slender longitudinal lines on the sides of the body (satyrus as in the other group); often forming rude nests in later life. Chrysalis with regularly conical ocellar tubercles, and laterodorsal tubercles of fourth abdominal segment strikingly larger than the others.

SPECIES: **interrogationis**, **comma**, **satyrus**.

POLYGONIA INTERROGATIONIS.—The violet tip.

[The violet tip (Gosse); semicolon butterfly (Harris); semicolon vaness (Emmons).]

Papilio interrogationis Fabr., Suppl. ent. syst., 424 (1798).

Cynthia interrogationis Fabr., Ill. mag. ins., vi: 281 (1807).

Vanessa interrogationis Harr., Hitchc. Rep., 590 (1833); Ins. inj. veg., 3d ed., 298-300, fig. 124 [P. i. fabricii figured] 1862;—Saund., Can. ent., i: 76-77 (1869).

Grapta interrogationis Doubl.-Hew., Gen. diurn. Lep., i: 197 (1848);—Morr., Syn. Lep. N. Amer., 53-54 (1862);—Edw., Can. ent., x: 71-74 (1878); xiv: 201-207 (1882);—French, Rep. ins. Ill., vii: 151-152 (1878); Butt. east. U. S., 182-185, fig. 51 (1886);—Middl., Rep. ins. Ill., x: 84 (1881);—Coq., ibid. 164 (1881);

Fern., Butt. Me., 51-52 (1884);—Mayn., Butt. N. E., 11-12, pl. 2, figs. 12, 12a [P. i. fabricii figured] (1886).

Vanessa (Grapta) interrogationis Möschl., Stett. ent. zeit., xxxi: 116 (1870).

Polygonia interrogationis Seudd., Bull. Buff. soc. nat. sc., ii: 251 (1875).

Vanessa p. interrogationis God., Encycl. méth., ix: 819 (1819).

Vanessa c-aureum Harr., Ent. corr., 280-281 (1869).

Figured by Glover, Ill. N. A. Lep., pl. 1, fig. 11; pl. 21, fig. 1; pl. 106, fig. 25 (?), ined.

POLYGONIA INTERROGATIONIS FABRICII.

With concolorous wings.

Grapta interrogationis Gosse, Newm. Ent., 138 (1840); —Lintn., Trans. Amer. ent. soc., ii: 313-319 (1869); iii: 197-204 (1870).

Nymphalis interrogationis Kirb., Syn. cat. Lep., 648 (1871).

Grapta interrogationis var. *fabricii* Edw., Butt. N. A., i, Grapta 4 (1871).

Polygonia interrogationis Scudd., Syst. rev. Amer. butt., 10 (1872).

Vanessa p. interrogationis God., Encycl. méth., ix: 301-302 (1819).

Vanessa c-aureum Boisd.-LeC., Lép. Amér. sept., 192-193, pl. 51, figs. 1-4 (1833).

Grapta fabricii Edw., Trans. Am. ent. soc., iii: 1-9 (1870).

Vanessa fabricii Kirb., Syn. cat. Lep., 181 (1871).

Nymphalis fabricii Kirb., Syn. cat. Lep., 648 (1871).

Figured by Glover, Ill. N. A. Lep., pl. 33, fig. 6, ined.

POLYGONIA INTERROGATIONIS UMBROSA.

With base of hind wings obscured above with dusky tints.

Papilio c-aureum Cram., Pap. exot., i: 28-29, pl. 19, figs. E. F. (1779); —Abb., Draw. ins. Ga. Brit. mus., vi: 39, figs. 26-27; xvi: 31, tab. 110; —Smith-Abb., Lep. ins. Ga., i: 21-22, pl. 11 (1797).

Polygonia c-aureum Hübn., Samml. exot. schmett., ii, Lep. i, Pap. 1, Nymph. 6, Hamadr. D. ang., 2, figs. 3-4 (1806).

Grapta c-aureum Gosse, Newm. Entom., 138 (1840).

Vanessa interrogationis Emm., Agric. N. York. v: 207, figs. 3. 5 (1854).

Grapta interrogationis Edw., Trans. Am. ent. soc., iii: 1-9 (1870).

Grapta interrogationis var. *umbrosa* Edw., Butt. N. A., i: Grapta 5 (1871).

Grapta umbrosa Lintn., Trans. Am. ent. soc., ii: 313-319 (1869); iii: 197-204 (1870).

Grapta crameri Scudd., Proc. Bost. soc. nat. hist., xiii: 276 (1870).

Polygonia crameri Scudd., Syst. rev. Am. butt., 10 (1872).

Figured by Glover, Ill. N. A. Lep., pl. 33, fig. 5, ined.

[Not Pap. c-aureum Linn.].

An déclin de l'automne, il est souvent des jours
Où l'année, on dirait, va se tromper de cours.
Et l'on dit; "N'est-ce pas le printemps qui revient?"

La fleur en tressaillant a reçu la rosée;
Le papillon revole à la rose baisée,
Et l'oiseau chante au bois un ramage brillant.

SAINT-E BEUYE.—*Pensée d'Automne*.

Imago (3: 8, 10, 12, 13; 11: 7). Head covered above with olivaceous hairs posteriorly, and vinous with many intermingled pale or whitish ones in the middle and anteriorly, the sides with reddish fulvous scales backed by whitish ones; palpi pale or whitish straw color beneath; on the sides, the first joint white with a few scattered fulvous scales, the middle joint white on the basal outer half, the apical upper half being brownish fulvous and the superior fringe the same, mingled with yellowish, especially at the apex; apical joint like the apical half of the middle joint, the lower outer surface with distant, delicate, not very long, black hairs; antennae above blackish, some of the basal joints very delicately annulate, with fulvous at their base; beneath, where naked, pale luteous, edged exteriorly on the scaled portion, continuously or nearly so with white, much more broadly at the bases of the joints than at their apices, extending to about the middle of the basal half of the club; club like the stalk, excepting that the apical three joints are bright luteous above, luteo-fuscous below; tongue very pale luteous, darker in the middle at the base and darker beyond the first whorl.

Thorax covered above with olivaceous brown scales and hairs, beneath with mingled vinous brown and pale hairs; fore legs fringed with the same, but dark reddish brown mingled with black in a slender stripe down the middle of the front; femora of the other legs nacreous, excepting on the inner under surface which is reddish brown, sprinkled with a few pale scales, and the tip which is yellowish or white; rest of legs pale straw yellow with a brownish tinge, paler on the tarsi than on the tibiae. Spines

dark reddish brown, sometimes luteo-castaneous; spurs yellowish, tipped with reddish brown; claws castaneous, paler at base, darker at tip and along the under edge; paronychial yellow; pulvillus black.

Wings above dark fulvous orange, clouded on apical half with dark cinnamoneous brown or dark ferruginous and spotted on basal half with black. *Fore wings* with upper portion of outer border straight, receding at an angle of about 45° ; dentation at tip of lower median nervule slight, angulated; lower angle produced considerably downward, well rounded; outer margin scarcely crenulate, powdered at base as far as origin of first median nervule with scarcely perceptible darker scales; costal edge yellowish, faintly marmorate with reddish; in the middle of the cell are two rather small, roundish, slightly unequal, black spots, the upper smaller, subquadrate, transverse, depending from the subcostal nervule at its first divarication, reaching from one-quarter to one-third way across the cell; the lower a little further from the base, opposite a point midway between the first and second median nervules, in the middle of the lower half of the cell, but not touching the median nervule, roundish, or, if ovate, longitudinal, slightly larger than the upper. Crossing the apex of the cell, the boundary veins of which pass through the middle of its interior half, is a large transverse bar, reaching below the median nervule, which it generally touches only by its inner edge, fading out above the subcostal nervule, of variable shape, but usually narrower below than above and in the middle one-half as broad as its length. Subparallel to the median nervule, and distant from it by nearly the width of the cell, is a nearly straight series of three pretty large, subequal, roundish spots in the median and medio-submedian interspaces, the upper and lower nearer the upper border of their interspace than the middle spot and generally touching it; midway between the lower median spot and the base of the same interspace is a more or less distinct blackish or reddish spot, the continuation of the medio-submedian spot, but clearly separated from it by the fulvous nervule; in the subcosto-median interspace, separated but a little from the transverse bar at the tip of the cell is a longitudinal, triangular, blackish fuscous dash or spot, its borders blurred, its apex outward and generally near the bottom of the interspace; it is about as large as the upper median spot. Beyond this, and separated from the basal portion by a limit which passes in a bent and curved direction from the costal margin, opposite the base of the third superior subcostal nervule, to just beyond the middle of the subcosto-median interspace, and through the middle of the median nervules to the inner border, where the submedian first approaches it closely, the wing is clouded with the cinnamoneous tint, infuscated and sometimes deepening into black by more or less frequent black flecks, on either side of the median area, and enclosing a somewhat obscure, sinuous, submarginal series of orange fulvous spots in all the interspaces, subparallel to the outer border, their outer limits distant from the outer border by the width of an interspace below the subcostal area, and by double that distance in the upper part of the wing; the spots subtriangular, their apices inward, ill-defined, of variable size, the upper ones often connected; the outer border is sometimes a little infuscated next their outer limits, and in the lower two subcostal interspaces generally deepens to a minute blackish crescent, followed by a short fulvous line; the whole outer border is rather narrowly edged with a pale bluish bloom, broadest next the nervule tips, and following them a short distance in the subcostal region; fringe cinnamoneous, tinged with dusky olivaceous in the middle of the wing, interrupted with yellowish in the interspaces in the upper half of the wing and more or less overlaid by the bloom. *Hind wings* with the outer border (61:18) very little crenulate, the tail of the upper median nervule two or three times as long as broad, the sides nearly parallel; the projection at the upper subcostal nervule slight, a little angulated, that at the lower angle small. Color the same orange and cinnamoneous tints as on the fore wings; the latter tint occupying relatively more of the outer portion than on the fore wings, and sometimes suffusing nearly the whole of the wing and particularly the lower half; there is a large transverse black bar crossing the upper subcostal and most of the costo-subcostal interspaces, broken by the upper subcostal nervule, which it strikes in the middle of

its basal half, a little further out below it than above; there are two other small black or blackish spots; one occupying the extreme base of the upper median interspace, the other following the extreme base of the lower subcostal nervule and crossing part of the base of the upper subcostal interspace in direct continuation of it; there is a submarginal series of indistinctly limited, triangular, fulvous spots similar to those of the fore wings, parted at the upper median nervule and lying at a distance from the outer border, to which they are parallel, by a little more than on the lower half of the fore wings; whole outer border, including the whole of the tail, and also the costal nervule edged as in the fore wing; fringe cinnamoneous, interrupted in the interspaces by pale olivaceous brown, overlaid in part by the bloom.

Beneath of a general wood brown tint of varying shades, made up of a very intimate and varying commingling of ochrey yellow and paler or deeper cinnamoneous scales, nearly the whole, but especially the basal two-thirds, more or less but almost always very slightly, washed with an exceedingly delicate pale bluish-hoary or plumbeous bloom, all the contrasts much more distinct in the ♂ than in the ♀. *Fore wings* with the basal fourth of the costal margin as far as the costal nervule white or yellowish white, heavily mottled with cinnamon brown; the limits of the transverse patch at the tip of the cell above are marked beneath by slender crenulate threads of cinnamon brown, between which the wing is a little darker reddish, especially in the ♂; from a point on the upper median nervule, as far beyond the tip of the cell as that is beyond the second divarication of the median nervule, a straight, cinnamoneous line runs to the middle of the basal four-fifths of the submedian nervule; at and within this mark, the inner border, as far as the submedian, is transversely and slenderly striped with dusky; and beyond this line, with alternating narrow bars of ochraceous and ferruginous; following this transverse line interiorly is a rather broad and nearly equal band, darker than most of the wing, made up of ferruginous tints, darker and more pronounced in the ♂ than in the ♀, the tint diminishing in depth interiorly, so that in the ♀ it is hard to determine its inner limit, but which in the ♂ is seen to be halfway to the base of the lower median interspace; crossing the middle of the cell is a cloudy, plumbeous, irregular, zigzag, slender, reddish-edged stripe connecting the base of the first subcostal and median nervules, often parted in the middle and much more distinct in the ♂ than in the ♀; a similar, quite small, ovate spot, parallel to the subcostal nervule, is seated on the median nervule a short distance from its base; in the outer half of the wing, excepting near the costal and outer borders, the nervules are delicately traced in yellow; the wing is palest in this same region, being ochraceous tinged slightly with ferruginous, and so presenting a considerable and sharply defined contrast with the mesial band in the ♂, but scarcely paler than the wood brown of the whole wing in the ♀; it is palest next the costal margin, but is interrupted by a large reddish fuscous cloud in the middle of the outer half of the border, more distinct in the ♂ than in the ♀, and which reaches nearly or quite to the upper median nervules; there is a sinuous series of nine blackish, sometimes indistinctly blue-edged dots in all the interspaces which open on the outer border, (two in the medio-submedian interspace) obsolete or obsolescent in the ♀, very inconspicuous in the ♂; the first is considerably nearer the base than the second, which is in the middle of the basal two-thirds of the apical subcostal interspace; below this they regularly recede farther from the outer border (that in the upper median in the middle of its interspace) until the lower median nervule is passed, where they are at the same distance from it as in the lower median interspace; beyond these the wing becomes darker again and is profusely mottled with most delicate, short, transverse threads of dark and paler cinnamoneous and ochraceous, much darker in the ♂ than in the ♀, the apex and lobe of the outer inferior angle more or less covered with bloom, little dots of which—noticeable only by the lens—occur midway between the sinuous row of black dots and the outer border of the wing; fringe cinnamoneous, the apical half, except at the nervule tips and the falcation, marked with white. *Hind wings* with an irregular mesial band of similar width and color to that of the fore wings, and like that deepest in tint externally; the outer edge, starting from the middle of the costal border, passes with

a more or less irregular and considerable curve, opening inwards, to the vein closing the cell; here it stops and starts again in the median area from the base of the straight portion of the upper median nervule, passing in a straight line to the middle of the medio-submedian interspace opposite the middle of the lower median nervule, and is then bent and directed toward the deepest part of the excision of the inner border; its inner limit is more regular and like the exterior is edged above the subcostal with a dark cinnamoneous line; the cell is bounded apically by a rather slender arcuate stripe of nacreous silver, its upper extremity just failing to reach the subcostal nervule and generally slightly produced toward the outer border, previous to which it is sometimes slightly strangled; beyond this, next the median nervule is a silvery dot, not so far from the inferior extremity of the silvery stripe as the length of the stripe; the base of the precostal nervure has also a white or silvery dot. In the apical half of the wing an arcuate series of dots like those in the fore wing, that in the lower median interspace in the middle of the outer two-thirds of the interspace; in the ♂ the dots are in the middle of a faint, rather broad, double arcuate, darker band, one in the upper and one in the lower half of the wing, parallel to the outer border; and midway between the dots and the outer border is another series, like those of the fore wings, of pale dots; the outer border quite resembles that of the fore wings in both sexes, except in wanting the bloom at the upper outer angle of the wing; fringe much as in the fore wings.

Abdomen above black, heavily covered with fulvous hairs and scales; beneath with intermingled hoary and fulvous scales, giving it a grayish appearance. Abdominal appendages (33: 19, 20): upper organ; hook slenderer at the base than in the other species, tapering throughout, as long as the body, very slightly arched, bluntly pointed. Clasps nearly twice as broad as long, slightly longer below than above, quadrate with rounded angles, the upper hinder angle produced to a small, rounded, incurved, triangular lobe about as long as broad; upper border producing at base a long and slender process longer than the clasp, on the basal half one-fifth as broad as the whole length, equal, curved strongly inward and directed a little backward, compressed, beyond twisted so as to become depressed, tapering regularly to a blunt point, nearly horizontal and directed backward and considerably inward; interior finger long and slender, tapering only at tip, a little curved and scarcely surpassing the upper border of the clasp.

POLYGONIA INTERROGATIONIS FABECIL.

Measurements in millimetres. Length of tongue 12.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	31.5	32.	33.75	34.	35.	36.
antennae	16.	16.75	17.5	17.	17.35	17.75
hind tibiae and tarsi...	10.4	10.6	11.1	10.75	11.	11.
fore tibiae and tarsi ..	5.25	5.4	6.2	5.25	5.1	5.65

POLYGONIA INTERROGATIONIS UMBROSA.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	28.	29.5	30.75	28.25	32.5	36.
antennae.....	15.	16.	16.2	14.	15.5	17.
hind tibiae and tarsi..	9.4	9.8	10.	7.6	10.	10.6
fore tibiae and tarsi..	5.	5.	5.	4.	5.	5.25

Described from 8♂ 13♀.

Dimorphic forms. The following peculiarities distinguish the form umbrosa from fabricii, the latter of which formed the basis of the foregoing description: First, as regards the form, the upper portion of the outer border of the fore wings is straight, receding at scarcely less than a right angle; dentation at tip of the lower median nervule slight, angulated; lower angle produced but little downward, rather broadly rounded;

outer border scarcely crenulate. The coloration of the upper surface of the fore wings differs in no respect from that of *fabricii*, excepting that the cinnamoneous tints of the outer half of the wing are deeper and often infuscated, and that the outer border shows scarcely any of the bloom, the tips of the nervules only having a few scattered bluish scales about them. *Hind wings* with the outer border (61:17) very slightly crenulate, the tail of the upper median nervule about half as long again as broad, the sides nearly parallel; the projection at the tip of the upper subcostal nervule slight and broadly rounded, that at the lower angle inconspicuous. These wings differ from those of the form *fabricii* much as the fore wings do, the parts which in *fabricii* were cinnamoneous becoming almost uniformly black and completely obliterating the submarginal spots; except faint traces sometimes seen near the costal margin; the fulvous portions also become deeper and so much less conspicuous; the bloom is not so nearly obsolete as on the fore wings, but excepting the tail, the outer border is much more narrowly margined than in the other form.

Beneath, the difference is more multiform, the general color of the wings of the ♀ being of a dull, dingy yellow brown with a slight olivaceous tinge, and more or less covered with a most delicate pale bluish bloom, not so intense as that bordering the outer margin of the upper surface, but much more noticeable than in the same sex of *fabricii*; the markings have the same localization as in that form, but they are more distinct and deeper than there, approximating those of the ♂ of *fabricii*, while the contrasts are scarcely greater than in the ♀ of the same form; the row of dots in the outer half of the wings is more distinct, indeed could hardly be overlooked by a casual describer, while they would scarcely be seen without search in the same sex of *fabricii*; they are even more noticeable than in the ♂ of *fabricii*; on the hind wings, where the glaucous tinge is more marked, this bloom is wanting in the double or broken transverse band, described in the ♂ of *fabricii* as accompanying and enclosing the transverse series of black dots; and finally, occupying the position of the hoary dots described as lying in *fabricii* midway between the black dots, and the outer border of all the wings, there is a faint, submarginal, often broken or partially obsolete, strongly crenulate streak of blue greenish atoms, receding from the border in the middle of the interspaces, more distinct and connected in the hind than in the fore wings, and never passing above the dentated portion of the fore wings.

In the ♂ the differences are of a similar character; the general tint of the wings is lighter than in *fabricii*, being of an ochraceous clay brown, the darker markings of the base of the wings being located precisely as in *fabricii* and scarcely deeper in tint, the greater contrasts in the wing being attained by the additional paleness of the lighter markings; the transverse row of dots in the outer half of the wing here attains its maximum, becoming almost conspicuous in the fore wings, and in the hind wings quite conspicuous, because the ferruginous bands in which they occur become developed as pretty large, approximated, round, ferruginous spots, especially in the lower subcostal, the median and medio-submedian interspaces, in which smaller, dull, olivaceo-fulvous spots are enclosed, having the black dots as their pupils; the hoary bloom of the wings is not so conspicuous as in the ♀, but is more distinct than in the ♂ of *fabricii*, and most noticeable on either side of the bands enclosing the dots on the hind wings and in the middle of the outer border of both wings; the submarginal crenulate line of blue-green scales is more distinct and continuous than in the other sex and indistinctly edged with black; it does not extend above the middle subcostal nervule of the hind wing or above the falcation of the fore wing; within these same limits there is close to the outer edge of the wing a delicate cinnamoneous thread, parallel to the outer border, sometimes infuscated.

The contrasts are also greater between the paler and darker markings of the fringe in both sexes and on both surfaces of *umbrosa* than in *fabricii*, and in the specimens I have examined there is in *umbrosa* an occasional absence of the silver dot outside the silver comma of the under side of the hind wings, which I have never seen to fail in *fabricii*.

As regards the abdominal appendages, the upper posterior lobe of the clasps is

slightly shorter and less produced, and the upper basal process a little slenderer in umbrosa than in fabricii.

Egg (64: 16, 17). Considerably higher than broad, somewhat narrowed apically, broadest below the middle, with nine to eleven, commonly ten, strongly compressed ridges, growing higher toward the summit, where they are nearly half as high as the width of the interspaces at that point; interspaces gently concave throughout, broken up by very faint lines .025 mm. apart. Color (C. V. Riley) at first dull bluish green, afterward becoming grayish green with silvery reflections, the ridges white. Height, .95 mm.; breadth, .7 mm.

Caterpillar. *First stage.* Head (78: 37) smooth, piceous with a bronze tinge, the hairs and all appendages black; coronal papillae scarcely perceptible. Body rather pale green, strongly tinged with ferruginous on posterior half, the anterior section of the segments on anterior half pallid above the lateral line, setting off the papillae which are everywhere brownish fuscous; hairs erect, black, generally bent in some part of their course, the angle rounded; the inclination is not uniform, but is usually forward on the laterodorsal row, forward on the laterostigmatal. Spiracles brownish fuscous. Legs and tips of prolegs blackish fuscous; rest of prolegs like ventral surface of body, which is paler green and more uniform than above. Length of body, 3 mm.; breadth of head, .5 mm.

Second stage. Head (78: 38) shining bronze black, the hemispheres surmounted by a compound tubercle, stouter and slightly shorter than those of the abdominal segments, all the hairs on the head arising from distinct papillae; all appendages black. Body olive green, slenderly and inconspicuously streaked with pallid white in maculate strigae which follow the lines of the spines; spines piceous, hairs blackish fuscous; spines of second and third thoracic segments slightly larger than the others, all the rest uniform, with subapical and extreme basal circlets of hair bearing papillae. Spiracles and prolegs color of body. Legs dark brownish fuscous. Length 6.5 mm.; breadth of head, .75 mm.

Third stage. Head (78: 39) shining bronze black, most of the papillae white, the coronal spines with elongate papillae, all the hairs pallid. Body olive green, varying in different individuals from rather light to very dark, distinctly strigate with white as in preceding stage, the dorsal striga double; dorsal and laterodorsal spines variable in coloration, those of the third thoracic and second abdominal sometimes, of the fourth and sixth abdominal segments generally, amber yellow, sometimes including and sometimes not, an annulus around the base of the spines; the other spines are generally black, sometimes tinged with olivaceous, occasionally pallid tipped; the hairs and thorns generally dark. Spiracles black with a distinct yellow annulus. Legs and outer side last joint of prolegs black. Length, 13 mm.; breadth of head, 1.35 mm.

Fourth stage. Closely resembling the final stage, but with a darker head (78: 40). Length, 22 mm.; breadth of head, 2.25 mm.

Fifth stage (74: 23, 27). Head (78: 41) uniform in color, varying from a fuscous brown to a rather pale yellowish brown, the field of ocelli black; summit spine stout at base and not long, the lateral spinules emitted below the middle, the basal portion about as broad as long, the spinules moderately slender and rather shorter than the apical portion of the main stem, which scarcely tapers. Body varying from luteo-castaneous to rufo-castaneous, with broad, but irregular dorsal, laterodorsal, laterostigmatal and ventrostigmatal, black or rich black-brown stripes, narrowly and interruptedly edged, at least above the spiracles, with pale yellow or pallid, sprinkled with ivory-white papillae (also found in the interspaces) and much broken and obscured, especially on the dorsal half of the body, with irregular strigae and blotches of pale yellow; on the thoracic segments the stripes are by this means, and by the confluence of some of the black parts of adjoining stripes, completely obliterated as such, and irregular, much broken, transverse, black, vermicular strigae take their place, and here there is a distinct and regular pale yellow dorsal line; there is also a rather slender, more or less interrupted and variable ventral stripe, and the bases of the prolegs are heavily clouded with black externally, merging into the ventrostigma-

tal band; laterodorsal spines of the second thoracic segment noticeably longer and rather stouter than the others; spines having the five spinules which form the wreath placed at an angle of about 40° with the apical part of the main stem, which is destitute of pile but generally bears three or four spinules of considerable magnitude. Most of the spines are luteous, though often rufous above the spiracles, and the thoracic ones or their spinules are often wholly blackish. Length, 35 mm.; breadth of head, 3.25 mm.

Chrysalis (83: 21, 22, 24-26. 40). Paler or darker wood brown, tinged with dark olivaceous, the head and thorax, but not the appendages, sometimes more or less livid or clay-brown. Abdomen with a pale dorsal stripe, enlarging in the middle of each segment and bordered more or less conspicuously with greenish brown; a dusky infra-stigmatal line, generally accompanied above by a moderately broad, greenish fuliginous band, bounded by the upper margin of the spiracles; a moderately broad, greenish fuscous, ventral stripe, margined with brown. The extremity of the tongue, occasionally the whole of it, and sometimes also the antennae, blackish. The whole body more or less faintly marked with an irregular web of dark brown in impressed lines, on the wings forming a large, irregular and imperfect, quadrate mesh, the lines crossing the equally marked veins. The laterodorsal tubercles of the metathorax and first to third abdominal segments are metallic on their posterior surface to a greater or less extent, generally silvery-nacreous; while the anterior face of most of them in favorable light shows a golden reflection. The other laterodorsal tubercles have a pale annulus at base, a dusky or blackish annulus above it, and are castaneous at tip, all these markings being more conspicuous on the anterior than the posterior face. The minute dorsal tubercles are dull yellow, as are sometimes the generally pallid suprastigmatal tubercles, edged anteriorly with black; but the last, on the first and second abdominal segments, are dull golden with no black edging. Ocellar prominences short, conical, blunt-tipped, separated at base by a truncate front. Mesothoracic tubercle (83: 24, 25) high, subquadrate, strongly compressed, subtruncate at tip, the front margin at first parallel to the hind, then curving, the anterior angle much more curved than the posterior; it is generally more or less marked with blackish fuscous on the sides. Length, 20-23 mm.; of ocellar prominences, 1-1.5 mm.; distance of these apart at tip, 2.75-3.25 mm.; width of thorax, 6.25-7.4 mm.; of abdomen, 5.75-7 mm.; height of thorax including tubercle, 7-7.75 mm.; of abdomen, 5.75-6.75 mm.

Distribution. (20: 3). This butterfly enjoys a more southern range than any other species of the genus, being found east of the Rocky Mountains from the borders of the Gulf of Mexico to the northern boundaries of the Alleghanian fauna and beyond. In the south it occurs from southern Texas to central Florida; in the west it has been taken in Arizona (Edwards), Kansas (Snow), Nebraska (Carpenter), Iowa (Allen, Osborn, Putnam), Wisconsin (Hoy), and even Montana (Edwards). It is generally very rare north of our boundary, single specimens being reported from Sault, Lake Superior, and Nova Scotia (Jones), while it is recorded as rare at Ottawa, Montreal (Caulfield, Lyman), and Quebec (Bowles),* though Gosse found it "quite numerous at Compton, P. Q., and Saunders raised it long ago at London, Ont."

In New England it is nowhere very abundant, except occasionally, and in the northern portions very rare; it is rather uncommon about Boston, at least of late years,† and the northernmost localities from which it is

*By an unfortunate error I once credited it to eastern Labrador.

†Dr. Harris in his report, speaking apparently of what he has seen in the neighbor-

hood of Boston, says the caterpillars sometimes abound to such an extent as totally to destroy the hops. It was very common in 1887.

reported are Brunswick (Packard), Norway (Smith), Hallowell, one specimen (Miss Wadsworth), and Bangor, Me. (Braun); Walpole, N. H. (Smith), and Stow, Vt., one specimen (Miss Soule); in the southern portion of our district it prevails more abundantly, although never to the same extent as in the southern and middle states of the Union.

Haunts and abundance. The butterfly is found in glades, gardens, and by the roadside in the vicinity of woods. It is very fond of sucking the sap which flows from wounded trees, especially oaks; and like many other Nymphalidae almost always alights on the trunks with its head downwards (Doubleday). So too, like the other species of *Polygonia*, it is attracted by the juices of decaying fruits.

More perhaps than any other species of this genus, it is subject, at least in New England, to considerable fluctuations in abundance from year to year, last year (1887) being the only one in which I remember to have met with it in any considerable numbers in thirty years, and Harris speaks of it, as just mentioned in a note, as occasionally destructive, which certainly cannot be charged upon it often in this latitude.

Oviposition. The eggs are usually laid on the under surface of leaves, occasionally on the upper, sometimes on the stem, the tender terminal leaves being preferred, and either singly or in depending columns of several, as many as five or six, and in one instance eight, according to Edwards. Six is the largest number we have met with, and three or four seem to be the most common. Edwards says that the number of ribs does not vary in any one column, so that this number, which is commonly ten, but ranges from eight to eleven, is probably the same in all the eggs laid by one individual. The eggs hatch in three to eleven days, according to the season.

Food plants. The caterpillars feed not only upon various Urticaceae, —elm (*Ulmus americana* L.), hackberry (*Celtis occidentalis* L.), nettle (*Urtica*), false nettle (*Boehmeria cylindrica* Willd.) and hop (*Humulus lupulus* L.),—but also upon the Linden (*Tilia americana* L.) and its varieties known under the names of basswood, lime and white-wood; the form figured by Abbot and Smith is var. *pubescens* according to Dr. Chapman. Dr. Harris suggests that it may be only the autumn brood which feeds upon hop, but Mr. Edwards finds the spring generation also on that plant. Hop and elm are its favorites. Ross carelessly gives the grape-vine as one of its food plants, and by an error of determination, Ambrosia was once mentioned by Edwards.

Habits of the caterpillar. According to Mr. Edwards the larvae are sometimes gregarious, in distinction from those of all the other species of *Polygonia*; and Mr. Doubleday says he has seen hops in Asheville, N. C., entirely destroyed by them, and the roof of a long veranda so closely hung with the pupae that he has dragged them down with the web in masses of

thirty or forty. Yet they do not seem to be strictly gregarious, although so very abundant in certain places as to bring the caterpillars into comparatively close contact. Not many eggs are laid on a single leaf, and though usually, at least while young, more than one caterpillar is found on a leaf (rarely more than four or five), these are never found feeding in rows side by side, as in the allied genera whose larvae are gregarious for a part or the whole of their lives. In his later writings Mr. Edwards has more correctly said that "the young larvae gather into a loose colony."

From the very start, in feeding, holes are eaten through the leaf, and the caterpillar "during the first stages feeds about the margin of this hole." During its whole life it rarely seeks any other concealment than to live on the under surface of the leaf, but in one case I discovered them on hop making nests precisely similar in every respect to those made by *P. comma*. It moves rapidly when young, and spins a thread very carefully for at least the first half of its life and to some extent until maturity, and it is very tenacious of it. It has the curious habit when resting after a meal of turning the front part of its body around abruptly, in which case the jaws come opposite the first pair of prolegs, and the head is held angularly, so that the coronal spine of that side of the head nearest the side of the body is uppermost.

Pupation. The chrysalis is often suspended from the leaf or stem of the plant on which the larva has been feeding. Mr. Angus once found one on a leaf of the Kentucky coffee tree (*Gymnocladus*). Mr. Gosse found one specimen "attached by the tail to a growing stalk of grass and of course hanging parallel to it." It is more frequently attached to the under surface of palings, etc. Judging from the dates given in Harris's Correspondence, the chrysalis state lasts in the north from eleven to seventeen or even twenty-six days. Gosse (in Canada) says eleven days, Edwards (in West Virginia), seven to eleven days. Braun in Bangor had them hang twenty days at the end of July. From an experience Miss Murtfeldt had in rearing this insect, she concluded (*Psyche* iv: 184) that the chrysalids with gilded spots on the back were those of the female, while those of the male were not thus ornamented and were darker. But this was merely an accidental occurrence.

Life history. This insect is double brooded, the butterfly hibernating and appearing again early in May. It disappears by the middle of June or earlier, having laid its eggs late in May and early in June. These hatch in from four to ten or eleven days, the larvae attain their growth rapidly, and after passing generally from eleven to fourteen days in the chrysalis state emerge as butterflies in July, some early specimens appearing during the last days of June. They continue on the wing until nearly the middle of August, laying their eggs late in July and throughout August, and the butterflies of the second brood appear toward the end of

August, probably seldom earlier than the 24th in the vicinity of Boston, and continue to emerge from the chrysalis until at least the middle of October, perhaps because the chrysalids of this brood, as shown by Dr. Harris, sometimes continue twenty-six days. This is possibly Doubleday's authority for saying (*Gen. diurn. Lep. i*: 197) of the whole genus that "the duration of the pupa state varies with the temperature from eleven days to a month." The length of this stage in the autumn and the occasional exceedingly late emergence of the butterfly—Oct. 26 (Harris), Nov. 10 (G. Dimmock)—would lend plausibility to the hypothesis that this insect may sometimes winter with us as a chrysalis.

In the south there are at least three broods, and Mr. Edwards thinks that in Florida there may be four or five. The butterfly passes the winter as in the north. Doubleday says (*loc. cit.*), "in east Florida, the beautiful sunshiny days of December and January prevent the torpid hibernation of most species of *Lepidoptera* which live through the winter, and, like many other butterflies, *Grapta interrogationis* is not unfrequently seen in those months. It is only the few cold and wet days of February that prevent its appearance on the wing for a short time." In West Virginia, says Edwards (*Can. ent.*, xiv: 204):—

Eggs laid by hibernating females give butterflies last of May; this is the first brood of the season. Eggs laid early in June give butterflies early in July, the second brood. Eggs laid last of July give butterflies in September, the third brood. Eggs laid through September give butterflies in October. Individuals of each brood are emerging for some weeks, say for a month, so that the earlier females may be laying eggs while the later members of the same brood are coming from chrysalis. But in the case of the fourth brood, it often can be only the earliest hatched larvae which produce butterflies, because by first of October we are apt to have frost and cold weather, and the food is thereby destroyed. . . . I think it probable that the butterflies of the third brood do not hibernate, but that the continuance of the species depends on the individuals of the fourth brood, usually but few in number.

Habits, flight, etc. The butterfly flies, as Maynard says, "with a nervous, rapid motion of its wings, and when it alights has the habit of raising [and lowering] them and moving about in a restless manner." It is a fearless insect. One female laying her eggs on an elm twig, flew to it and continued her maternal occupations after it was plucked, even under the very eyes of no less an entomologist than Mr. Riley. Mr. Mead states that "one afternoon while preparing my baits for evening [sugared cloths for moths], a fine *Grapta interrogationis* hovered around the tree for a moment and then lit close by, and unrolling its proboscis, feasted on the nectar. While engaged in the absorbing operation I readily captured it between thumb and finger" (*Can. ent.*, v: 80).

Dimorphism. This butterfly presents a most interesting case of dimorphism, first elucidated by Mr. Edwards. The two forms differ so greatly and constantly from each other, not only in coloring but in the form of the wings and even in the abdominal appendages that they have been consid-

ered distinct species ; in each form, too, the sexes differ considerably in the coloration of the under surface of the wings, so that the species includes four sets of individuals, which may be distinguished quite as readily as a great many acknowledged species of the best studied faunas ; but Mr. Edwards has succeeded in rearing each from the eggs of the other, and others have since done the same, leaving no doubt of their actual identity. Mr. Edwards alone had bred in 1882 more than twenty different batches, mostly from eggs the exact parentage of which was known, and raised over five hundred butterflies. In his experiments up to 1878 all the eggs laid by hibernating *fabricii* produced *umbrosa*. The eggs of the second brood produced 88 per cent *umbrosa* ; of the third brood 55 per cent *umbrosa* ; of the fourth brood, all *fabricii*. Including experiments made between 1878 and 1882 these proportions varied only in the second and third broods, which were changed respectively to 83 and 68 per cent. This is in West Virginia. In New England, where there are but two broods, the difference is nearly as decisive, to judge from the few experiments known to me. Here the eggs laid by the hibernating females produce nearly but not quite all *umbrosa* ; and the eggs of the last brood almost invariably produce only *fabricii*. Mr. Carl Braun for instance obtained in Bangor, Me., one hundred eggs from a hibernating *fabricii* about the middle of June, and of the resulting butterflies all but two (which were *fabricii* ♀) were *umbrosa* ; while in the same year a brood raised from caterpillars of the second brood produced only *fabricii*, four males, three females.

Mr. F. H. Sprague's experience tells about the same story, excepting in 1887, when he writes me "the August brood was mixed, about evenly divided between the two forms." He adds that the later ones (which he looks on as a third brood) were *fabricii*, though an *umbrosa* was reared in the last week in August ; so too, the same year, I bred about the middle of October a single male of the form *umbrosa*.

The wintering butterflies then all belong to the form *fabricii*, and from their eggs are produced, in New England, almost exclusively the form *umbrosa*, which in their turn yield only *fabricii*. The dimorphism is therefore seasonal but not exclusively so.

A similar dimorphism affecting both the coloration and the contour of the wings is found in some other species of this genus, but in none is it so marked as in this, and in some it is very slight. The step from such dimorphism as this species presents to the formation of distinct species would seem to be very slight.

Enemies. A large proportion of the chrysalids of this species, according to Harris and Doubleday, are destroyed by *Pteromalus vanessae* Harr. (89: 3) ; Harris obtained them from chrysalids at the end of March in 1831. Oftentimes, says Mr. Bethune, "we have been disappointed in our attempt to raise the butterfly of this species by this little fly. Every-

thing apparently goes on well, and the caterpillar assumes the chrysalis state, but by and by, instead of a butterfly, out comes, through a hole in the side, a swarm of tiny flies. If it were not for these creatures the caterpillar would soon become a formidable and destructive pest" (Rep. Ent. soc. Ont., 1872, 32). Mr. Edwards has had a worse experience: "When it is considered how many eggs are laid, and that so short a time intervenes between the egg and the imago, it is surprising how few butterflies of this species are the result. From eggs that were laid on my vines in July and August, amounting, I am sure, to many hundreds, very few larvae were hatched, and gradually these became more and more scarce, so that at last I could with difficulty discover a single one. The eggs are destroyed by spiders and various insects by wholesale. I have had the contents of one of my kegs swept away in a night, leaving not a trace of shell behind, and in the same way I have lost scores of small larvae. . . . Finally after the larvae have escaped all apparent danger and have changed to chrysalids, the imago therein is often destroyed by ichneumon flies. So that it is doubtful if much more than two per cent of the eggs laid produce butterflies." (Butt. N. A., i, Grapta 5.) *Hoplismenus morulus* (88:9) is also a foe to this caterpillar, which changes to chrysalis with the parasite within the body; the latter makes its escape later by decapitating the chrysalis (88:16), as shown by a specimen received from Rev. Mr. Bethune. The eggs are often destroyed by a minute parasite, *Telenomus graptae* How. (89:9), a dozen or more of which will issue from a single egg a day or two after others laid at the same time have given birth to caterpillars. According to Mr. Gentry, either the caterpillar or the butterfly (he does not say which, but we presume the latter) is devoured by the wood pewee, *Contopus virens* (Linn.).

Desiderata. The time of appearance of this insect in the New England states is not yet determined with sufficient exactitude, the account given here requiring complete verification; the haunts of the butterfly, its mode of flight as contrasted with the other species of the genus, and the question of its hibernation, all demand examination; and what relation the two forms of the perfect insect bear to the seasons or the different localities in which they occur needs the very closest investigation. Is it anywhere single brooded, and if so, which form prevails? Does the hibernating brood ever contain any butterflies of the form *umbrosa*? Is there any evidence of the slightest constant or comparative difference between the two forms in such habits or peculiarities as vary in the different species?

LIST OF ILLUSTRATIONS.—POLYGONIA INTERROGATIONIS.

General.

- Pl. 20, fig. 3. Distribution in North America.
 88:9. *Hoplismenus morulus*, a parasite.
 16. Chrysalis of *P. interrogationis* as cut by *Hoplismenus morulus* in escaping.

89:3. *Pteromalus vanessae*, a parasite.

9. *Telenomus graptae*, an egg parasite.

Egg.

- Pl. 64, fig. 16. Columns of eggs.
 17. Single egg, colored.

Caterpillar.

- Pl. 74, figs. 23, 27. Side view, colored.
78: 37-41. Front view of head in stages i-v.

Chrysalis.

- Pl. 83, fig. 21. Dorsal view, outline.
22. Side view, outline.
24, 25. Outline of mesothoracic tubercle from the side.
26. Outline of head in front.
40. Side view, colored.

Imago.

- Pl. 3, fig. 8. P. i. fabricii ♀, lower surface.
10. P. i. umbrosa ♀, lower surface.
12. P. i. fabricii ♂, both surfaces.
13. P. i. umbrosa ♂, both surfaces.
11: 7. Both surfaces.
33: 19, 20. Male abdominal appendages.
61: 17. P. i. umbrosa, outline of hind wing.
18. P. i. fabricii, outline of hind wing.

POLYGONIA COMMMA.—The hop merchant.

[The orange comma (Gosse); the comma butterfly (Harris); white-c butterfly (Fitch); comma vaness (Emmons); the hop merchant (New York hop growers, vide Smith).]

Vanessa comma Harr., Ins. inj. veg., 1st ed., 221 (1841).

Grapta comma Doubl.-Hew., Gen. diurn. Lep. i: 197 (1848);—Morr., Syn. Lep. N. Amer., 54-55 (1862);—Lintn., Proc. Ent. soc. Philad., iii: 55-57 (1864);—Belt, Trans. Nova Sc. inst. nat. sc., ii: 90 (1868²);—Beth., Rep. Ent. soc. Ont., 1872: 32, fig. 24 (1873);—Edw., Can. ent., v: 184 (1873); Butt. N. A., ii, Grapta 1 (1874); Can. ent., x: 69-71 (1878); xiv: 189-194 (1882);—French, Rep. ins. Ill., vii: 152 (1878); Butt. east. U. S., 185-187 (1886);—Middl., Rep. ins. Ill., x: 84 (1881);—Fern., Butt. Me., 52-53 (1884);—Mayn., Butt. N. E., 12-13, pl. 2, fig. 13, 13a (1886).

Polygonia comma Scudd., Bull. Buff. soc. nat. sc., ii: 251 (1875).

Vanessa c-album Boisd.-LeC., Lép. Am. sept., 190-191 (1833).

Grapta c-album Gosse, Can. nat., 174, 192, 246 (1840);—Morr., Syn. Lep. N. Amer., 55 (1862).

Vanessa (Grapta) c-album Fitch, 3d Rep. ins. N. Y., 114-116 (1859).

Figured by Glover. Ill. N. A. Lep., pl. 92, fig. 17; pl. 95, figs. 21, 22; pl. O, fig. 10, ined.

POLYGONIA COMMMA HARRISII.
With concolorous wings.

Vanessa comma Harr., Ins. inj. veg., 3d ed., 300-301, pl. 4, figs. 1-2 (1862).

Grapta comma Edw., Butt. N. A., i, Grapta 2, figs. 1-5 a, b (1871).

Grapta comma var. harrisii Edw., Can. ent., v: 184 (1873).

Nymphalis comma Kirb., Syn. cat. Lep., 648 (1871).

Polygonia comma Scudd., Syst. rev. Am. butt., 10 (1872).

Polygonia comma var. harrisii Scudd., Bull. Buff. soc. nat. sc., ii: 251 (1875).

POLYGONIA COMMMA DRYAS.

Base of hind wings dusky above.

Grapta dryas Edw., Trans. Amer. ent. soc., iii: 17-18 (1870); Butt. N. A., i, Grapta 3, figs. 1-6 (1871).

Nymphalis dryas Kirb., Syn. cat. Lep., 648 (1871).

Polygonia dryas Scudd., Syst. rev. Am. butt., 10 (1872).

Grapta comma var. dryas Edw., Can. ent., v: 184 (1873).

Polygonia comma var. dryas Scudd., Bull. Buff. soc. nat. sc., ii: 251 (1875).

Freuet euch des wahren Scheins,
Euch des ernsten Spieles.
Kein Lebendiges ist ein Eins,
Immer ist's ein Vieles.

GOETHE.—*Urworte.*

Sometimes I let a sunbeam slip,
To light her shaded eye;
A second fluttered round her lip
Like a golden butterfly.

TENNYSON.—*The Talking Oak.*

Imago (3: 1, 3, 4, 7). Head covered with long whitish, dusky, and pale olivaceous hairs, with a slight tuft of yellowish ones outside the base of each antenna; behind the eye covered with mingled pale and tawny scales. Basal half of palpi pale buff, tinged faintly with greenish, and bordered along the base of the inferior fringe with

dark tawny scales; fringe itself buff, with intermingled black hairs, and along the middle of its inferior surface a row of dark tawny mingled with fuscous scales; the basal half of the middle joint sometimes white above; apical half of palpi dark ferruginous tawny, the fringes the same, but tipped especially toward base with pale or more yellowish buff. Antennae blackish brown above, the inner inferior surface, excepting a few basal joints, naked and luteous, the outer inferior surface and all the inferior surface of the basal joints, white, the apical half outwardly, the basal joints wholly, interrupted with blackish, on the apical half of the antennae mingled with fulvous; club blackish, with a few obscure, dark, tawny scales, beneath blackish fuscous, the apical three joints luteous. Tongue pale luteous, the apical two-thirds infuscated at the edges.

Thorax covered above with silky olivaceous hairs, beneath with vinous-brown, hoary-tipped hairs. Fore legs yellowish buff, marked down the middle with a black stripe; femora of other legs dusky, heavily flecked with pale scales, the slight inferior fringe buff, edged at base interiorly with black; inner side of upper surface of tibiae buff, the outer side and the tarsi whitish or very pale buff. Spines castaneous, darkest on the tarsi, spurs similar, reddish toward tip. Claws dark reddish fuscous; paronychial pale fuscous; pulvillus black.

Wings above dark fulvous orange, marked with black and fuscous. *Fore wings* (38:10) with the upper portion of the outer border slightly concave, the dentation rather less than rectangular, that at the tip of the lower median nervule rather prominent and angulated; outer border a little crenulate. The costal edge is rather conspicuously yellowish, pretty uniformly and minutely interrupted with blackish; in the cell, at the base of the median interspaces, and in the middle of the medio-submedian interspace, are roundish spots, and at the tip of the cell a transverse bar—all of which repeat exactly in color, form and relative position the similar markings of *interrogationis*; there is, however, no spot (nor trace of a spot in any specimens I have been able to examine) near the base of the subcosto-median interspace. The outer border, to the depth of half an interspace—above the lowest subcostal to a much greater depth—blackish, its inner limit often deeper than the rest, and its outer limit narrowly edged with a generally faint bluish bloom. In the middle of the lower two subcostal interspaces, midway between the last divarication of the subcostal nervule and the outer border, are two black dots, preceded by a faint yellowish tawny, minute crescent, and followed by a short, slender, longitudinal dash of the same; the yellow crescents preceding the dots are surmounted by a larger, more distinct, paler crescentic spot crossing two interspaces, and forming a series with the others; the dashes beyond the black dots form part of a series of submarginal fulvous lunules which occupy all the interspaces below them, seated on the outer dark margin and only conspicuous when the outer part of the wing is clouded somewhat with ferruginous; this series is sometimes almost entirely wanting, at others is present to such a degree as to form a transverse band, attenuated in the middle, but broad, and, on the heaviest marked individuals, deepening into blackish above and below; it occupies the same position as in *interrogationis*; fringe black, most distinctly so at the nervule tips, broadly interrupted in the interspaces with dusky fulvous or with whitish, the latter particularly in the median interspaces. *Hind wings* (61:20) with the outer border somewhat crenulate, the tail of the upper median nervule longer than broad, a little incurved and scarcely tapering, the projection at the tip of the costal slight, angularly rounded, that at the upper subcostal rather prominently rounded. A transverse blackish bar crosses the costo-subcostal and first subcostal interspaces, in the latter at a little greater distance from the base than in the former, and removed by a little more than its own width from the base of the interspace; parallel to it a narrow, transverse, blackish bar reaches from near the base of the middle subcostal nervule, across the base of the lower subcostal to the middle of the vein closing the cell; the extreme base of the upper median interspace is filled by a triangular blackish spot, about as large as the central bar, and occasionally the lower median interspace is infuscated a little below it; the outer two-fifths of the wing is of a much darker ferruginous tint, sometimes

deepening into blackish, especially outwardly: inwardly it blends gradually into the basal color; crossing the middle of this darker portion, its outer edge at a distance of more than half an interspace's width from it, is a series of yellowish fulvous, roundish or triangular spots with ill-defined edges, becoming more or less transversely linear below the upper median nervule, nowhere so high as broad, and always clearly separate from one another; margin of the wing distinctly, but rather narrowly, covered with a hoary bluish bloom, most conspicuous at the nervule tips; fringe blackish, broadly interrupted in the interspaces with whitish, partly overlaid by fuscous scales.

Beneath, dark brown on the basal half of the *fore wings*, limited by a bent line, the limbs of which are usually a little concave, opening outward, running from the costal margin (close to the tip of the costal nervule) to the base of the straight portion of the upper median nervule, and thence to the inner margin before its middle. Within this area the ♂ has the following markings, some of which in the ♀ are always very obscure, and others at a distance from the costal margin, wholly obsolete: the darker portions are outwardly and more or less distinctly limited as a band by a bent line, the upper half of which reaches to the median nervule and is parallel to the similar portion of the outer bent line, and so far distant from it as to make this part of the band fully three-fourths as broad as its length; the lower half is also sub-parallel to the lower part of the outer bent line, but the band is only half as wide as above and tapers toward the inner border; above the middle of the cell the band is bordered on either side by a zigzag thread of black, and there are also a few similar marks within it; it is followed interiorly by a hoary patch, while in the cell are three oblique, mostly black edged, dark brown, linear streaks, about as long as half the width of the cell, one seated, on end, on the median nervule close to the base and directed parallel to the subcostal nervule, a second on the same nervule at its first divarication directed toward the upper outer angle of the cell, and a third depending from the costal margin directed between the first two; the whole costal margin is irrorate with blackish ferruginous and whitish or yellowish; the apical half of the wing is paler, being ashy brown (♀) or hoary ash (♂), excepting the outer border and a quadrate clouded, darker portion, somewhat darker and much more distinct in the ♂ than in the ♀, occupying the whole apex of the wing above the lower subcostal interspace and beyond the origin of the third superior subcostal nervule, darkest at its interior and inferior borders, and enclosing in its middle next the costal margin an obscure paler spot, reaching to the next, at the lower subcostal nervule. This paler part of the wing is frequently tinged with olivaceous in the ♂, particularly outwardly and near the inner margin, and in both sexes it is varied by frequent, short, transverse, delicate threads of blackish and reddish brown or fuscous; there is a transverse row of black dots, often obsolete in some of the interspaces and never conspicuous, but almost always present in the lower two subcostal, lower median and medio-submedian interspaces, in a similar position to those of *interrogationis*; the outer margin above the subcostal angulation is slightly paler than the surrounding parts in the ♀, but in the male is deeper and generally distinctly and rather broadly olivaceous; below the angulation and excepting the extreme lower angle, which is like the apex, the margin is dark like the base in the ♀, but in the ♂ is greatly variegated, being olivaceous brown enlivened by many blackish, fuscous, and dark ferruginous scales, mostly arranged in transverse rows, and limited, parallel to and at half an interspace's distance from the outer border, by a slender black stripe, enclosing an interrupted thread of bluish green scales; the first inferior subcostal nervule is broadly bordered with ferruginous to its tip. Fringe much as above. *Hind wings* of the same general hues as the fore wings, the darker base separated from the paler external portion by a black bordering thread, which in the upper half of the wing has a sinuous course, from the middle of the outer two-thirds of the costal margin to the lower subcostal nervule at a short distance from its base, where it is interrupted by a silver comma; the lower half has a crenulate, nearly straight, general course from the upper median nervule, an interspace's width from its base, toward the deepest part of the excision of the inner margin of the wing. Within this the wing is nearly uniform dark brown

in the ♀, with rather distant, short, transverse, inconspicuous threads of blackish ferruginous, but in the ♂ it is considerably, although rather obscurely, variegated; on the basal fourth of the wing, above the subcostal nervure, there is a large, ashy patch, and dusky irregular streaks cross the basal half of the cell; the outer portion is darkest and forms an indistinct, broad, intramesial band, while the transverse threads of the ♀ are also not wanting; at the apex of the cell is a rather heavy silvery comma, generally rather broader in the ♂ than in the ♀, strongly curved, sometimes rather bent at its lower inner side, opening toward the tip of the costal nervure, its extremities usually thickened, particularly in the ♂, the upper extremity just failing to reach the subcostal nervure, the lower half following the upper median nervure from its extreme base outward; the outer half of the wing in the ♀ is paler like the fore wing, gradually growing dark again toward the outer margin, and with a very obscure, almost obsolete, series of blackish dots, arranged as in interrogationis; in the ♂ it is variegated as in the fore wing, but the paleness of its basal half is almost always intensified by a lilaceous hue, reaching nearly to the series of black dots which are scarcely more noticeable than in the ♀; parallel to the outer border is a very obscure series of yellowish spots, the counterparts of those on the upper surface, followed above the middle of the subcostal area by slight ferruginous, below by blackish and bluish, markings; the upper portion of the dentation, from its very base, is bordered equally, without regard to the nervures, by a band, as broad as the dentation, of mingled black, fuscous and lilaceous scales; the other parts of the border are yellowish olivaceous, more or less infuscated. Fringe as above.

Abdomen above black, heavily covered with fulvous hairs and tawny scales; beneath with mingled scale-like hairs of the colors prominent on the under surface of the wings. Appendages of the male (33:14): upper organ much stouter at the base than in the previous species, tapering only on the basal half, somewhat arcuate, pointed, fully as long as the body with an inferior tooth at base. Clasps twice as broad as long, quadrate with rounded angles, the upper, hinder angle produced to a moderately long, equal, incurved lobe, fully half as long as the clasp, twice as long as broad, rounded at the apex, directed upward and backward; upper border producing at base a long and slender process, much longer than the clasp, broadest in the middle, tapering but little toward the base but rapidly and pretty regularly toward the pointed apex, which is distinctly excised on the inner edge; at its base it is strongly bent and slightly twisted so as to become horizontal and depressed, directed backward and slightly inward; beyond it curves a little downward and at the middle curves strongly inward; interior finger long and slender, tapering a little on the basal half, approaching throughout the hinder edge of the clasp and scarcely surpassing the upper edge.

POLYGONIA COMMA HARRISH.

Measurements in millimetres. Length of tongue, 10.5.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	24.25	25.25	25.5	24.75	27.25	27.25
antennae.....	13.5	13.75	14.	13.2	14.5	14.5
hind tibiae and tarsi.....	8.5	8.5	9.	9.	9.	9.
fore tibiae and tarsi.....	4.5	4.5	4.75	4.	4.75	4.75

POLYGONIA COMMA DRYAS.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length fore wing.....	24.	25.5	26.75	25.25	28.5	28.5
antennae.....	13.	13.25	14.	13.	13.75	13.75
hind tibiae and tarsi.....	8.1	8.5	8.75	8.	9.	9.
fore tibiae and tarsi.....	4.	4.4	4.5	4.	4.4	4.4

Described from 8 ♂ 7 ♀.

Dimorphic forms. The following peculiarities distinguish the form *dryas* from *harrisii*, which served as the basis of the foregoing description: First, as regards form, the fore wings have the upper portion of the outer border slightly concave, the dentation nearly rectangular, that at tip of lower median nervule slight and broadly rounded; outer margin slightly crenulate. The hind wings (61:19) have the outer border scarcely crenulate, the tail of the upper median scarcely longer than broad, scarcely tapering; the projection at the tip of the upper subcostal slight, angulated, that at the lower angle very small, rounded.

The coloration of the upper surface does not differ from the form *harrisii*, except in the considerable infuscation of the apical half of the hind wings, which is generally more intense and extensive in the ♀ than in the ♂, and by which the submarginal series of fulvous spots are obscured or very nearly obliterated, and the basal, blackish markings of the median interspaces blended with the rest; but the other black markings near the upper half of the middle of the wing remain nearly or quite as distinct as before. Beneath, the ♂ differs almost too little from the ♂ of the form *harrisii* to merit notice, the yellow tints generally prevailing here and the brown there; the ♀ however, is quite distinct: the distinction in tone between the basal and apical halves is almost lost, and the general tint is a nearly uniform brownish, somewhat smoky, yellow; in the *fore wings* faint traces of the intramesial band remain, especially toward either border, and the spots in the cell are represented by their bordering lines: but the apical cloud would hardly be noticed but by a comparison with the other form, and the whole apical half of the wing, excepting the outer border, is nearly uniform in color, liberally streaked with short transverse threads of pale ferruginous scales. The transverse series of dots is more distinct than in *harrisii*, and just within its upper extremity is a slight, transverse, whitish, tapering bar depending from the costal border; the outer border is marked much as in the ♂ but rather less distinctly. The *hind wings* preserve the general character of the fore wings, but the row of dots is enclosed in a common band of slightly fuscous ferruginous, and within it the apical half of the wing is faintly tinged with a lilaceous bloom, which sometimes also borders it externally; the outer border resembles that of the ♂ very closely, differing from it only as the fore wing does from the fore wing of the ♂.

Egg (64:18). Short blunt ovate in shape, broadly rounded beneath, above a little flattened, broadest in the middle of the lower two-thirds, with eleven strongly compressed vertical ribs which increase in height from base to summit, more rapidly above; surface between them scarcely concave, smooth, crossed by exceedingly fine lines, which traverse also the ribs and make them appear striate. The ribs are about .06 mm. high at the top, but only one-third of that in the middle of the egg; they are about .22 mm. apart, and the cross lines .02 mm. apart. Color of egg pale green, glistening, the ribs pale. The termination of the ribs above leaves a free central space .17 mm. in diameter. Micropyle rosette .065 mm. in diameter, made up of a cluster of nearly equal hexagonal cells, about .01 mm. in diameter. Height of egg, .8 mm.; width at greatest, .7 mm.; at summit, .4 mm.

Caterpillar. *First stage.* Head piceous. Body above varying with age from a pale straw color to a dull rather dark green, the anterior portions of the segments livid, but with the last two segments varying from light to purplish brown; beneath yellowish green. Papillae and hairs (86:67) black. Legs and prolegs dusky. Length 2.75 mm.

Second stage. Head dark brown [probably piceous]. Body brown-black or black, with whitish lines at the incisures. Spines black, arising from papillae which are black, or, in those with white lines, white on the third thoracic and second, fourth, and sixth abdominal segments; hairs black. Legs black; prolegs olivaceous. Length, 3.3 mm. (After Edwards.)

Third stage. Head piceous, most of the papillae black, the others white, the hairs pellucid or dusky. Body reddish brown, heavily traversed by transverse dusky lines, becoming blackish next the base of the spines; the infrastigmatal fold sometimes a little pale. Spines black, excepting the laterodorsal series on the fourth and sixth

abdominal segments, and sometimes the tips of some of the dorsal ones in the same vicinity, which are white; hairs dusky pellucid. Legs black; prolegs, excepting at base, dusky. Length, 8 mm.

Fourth stage. Head piceous, the coronal tubercles black, the papillae white or black, the white predominating. Body black, the segments crossed posteriorly by two or three more or less slender white lines, sometimes broadening into spots, and anteriorly by an oblique whitish bar, extending backward on either side from the outer base of the dorsal spines; an infrastigmatal yellow band, above which an oblique bar, and some minute white spots on the posterior part of each segment. Spines of dorsal series always, and of laterodorsal usually, white, the others variably black or white; spiracles black, with a distinct white annulus. Length, 10 mm. (After Edwards.)

Fifth stage (74: 38). Head (78: 36) light pea-green, the summit spine mostly black, very stout and not long, the lateral spinules emitted near the middle, the basal half nearly as broad as long, the spinules stout and of equal length with the apical half of the main stem; tubercles usually spiniform, sometimes hemispherical, pellucid, each tipped with a long white bristle; ocelli and mouth parts black. Body light pea-green, with yellowish blotches which predominate upon most of the abdomen; there is a small spot of a dull, dark, orange color just in front of and above the laterostigmatal spines of the fourth to sixth abdominal segments. Spines furnished with a wreath of five spinules, which are placed at an angle of about 60° with the apical portion of the stem; below them are seldom more than one or two spinules of any magnitude, and this portion of the main stem is covered with short, exceedingly delicate pile; they as well as the spinules are generally colorless, and the bristles black, but sometimes the terminal half of the spinules is also black; the spiniform tubercles are white or greenish. Spiracles black. Legs pale testaceous. Length, 25 mm.

Chrysalis (83: 27, 29, 30, 39, 46-48). Nearly uniform pale wood brown, tinged, especially in certain lights, with pale green and streaked very faintly across the middle of the wings with the same; tongue and legs faintly tinged with pale salmon, the tongue infuscated at tip, the legs interrupted with pale green; joints of antennae marked with faint fuscous lines; ocellar tubercles conical, pointed, pretty regular, the outer margin continuous with the sides of the prothorax, the inner inclined toward each other at nearly a right angle, although they do not meet but form an angle of 130° with the front of the head; the tubercles above and the thoracic ridge marked with greenish fuscous; mesonotal tubercle moderately high, much the highest posteriorly, where it is about half as high as long, posterior border straight and nearly perpendicular, perhaps turned forward a little, anterior border curving regularly and broadly up to the highest point; middle of each half of metathorax and of the first to third abdominal segments with a large mercurial spot, that of the metathorax largest and centred with blackish, that of the second segment situated on the posterior half of the tubercle, that of the third segment faint and diffused; all excepting the last bounded, laterally at least, by fuscous lines; beyond a slightly paler dorsal band, made more conspicuous by a brownish fuscous line which edges it; posterior surface of the laterodorsal tubercles edged on either side with brownish fuscous streaks; a stigmatal, open, brownish fuscous band, tinged with greenish and much more distinctly marked along its under border; on the fifth and sixth segments, a slightly infuscated ventral band, edged more distinctly with fuscous; outer edges of the cremaster black; spiracles pale brown with black lips. Length, 21 mm.; height at thorax, 7.25 mm.; height at first abdominal segment, 5 mm.

Distribution (20: 2). This eastern butterfly is one of the characteristic members of the Alleghanian fauna; toward the south it is found abundantly in the Kanawha and Elk River valleys of West Virginia (Edwards) and occurs about Louisville, Ky. (Belknap, Yale Coll. Mus.), and in North Carolina and Tennessee (Edwards); westward it has been taken in

scanty numbers in Wisconsin (Hoy), Iowa (Allen, Osborn), Fort Niobrara, Neb. (Carpenter) and Kansas (Snow), and is even recorded from Texas (Edwards). Reakirt indeed reported it from Colorado, but probably by mistake for some other species then undescribed. In the north, Edwards records it from Fort Simpson, Mackenzie River, British America, which is too far in advance of its ordinary range to be probable; as he had butterflies from the fort of the same name on Albany River and Jenner Weir reports it from Moose Factory near there, the more southern fort is the probable locality meant. It is found in various parts of Canada, especially toward the east;—Nepigon, north of Lake Superior (Fletcher), Lake Cameron (Mead), Ottawa (Billings, Fletcher), Montreal (Caulfield), Compton (Gosse), Quebec, “very common” (Bowles), and the Rouge district (D’Urban);—as well as in Nova Scotia “rare” (Jones), and even in Anticosti (Strecker).

It is found throughout New England, excepting in the White Mountain region and perhaps other elevated portions of the northern counties: it has, however, been taken on Camel’s Hump, Vt. (Sprague), and given as a probable inhabitant of Norway, Me. (Smith); the only other localities from which it is reported are Walpole (Smith) and Plymouth, N. H. (Scudder); Orono (Fernald), Portland, “rare” (Lyman), and Hallowell, Me. (Miss Wadsworth); the vicinity of Boston (numerous collectors), Amherst (Stearns, Marsh, Scudder), Holyoke and Granby (Scudder), Springfield (Dimmock) and Williamstown, Mass. (Scudder); Farmington (Norton), South Windsor and New Britain (Scudder) and New Haven, Conn. (Smith); and Portsmouth, R. I. (Hambly). It is nowhere a very common insect in New England, excepting perhaps in the extreme south. Edwards, however, says that when found it is abundant, and calls it “one of the commonest” butterflies in West Virginia. It is undoubtedly a local species, as Edwards states, but the cause of its restriction is unknown.

Oviposition. In but a single instance have I found a solitary egg of this butterfly; in all other cases they have been piled in columns varying from two to nine eggs, the average of those I have seen being a little over four. Very often several columns will be found on a single leaf, and these are probably laid by the same butterfly at one alighting, for the columns are frequently close together, separated sometimes by scarcely more than the width of an egg. They are almost always laid upon the under surface of leaves, though occasionally upon the stem of the plant selected, and Edwards says upon the tendrils of the hop. They gleam in the sun like dewdrops. The egg hatches in four or five days.

Food plants. The hop (*Humulus lupulus*), elm (*Ulmus americana*), nettle (*Urtica*), and false nettle (*Boehmeria cylindrica*), all belonging to the Urticaceae, are probably the only food plants of this larva, hop

appearing to be the favorite. Packard gives also currant, and French basswood (*Tilia*) as food plants, plants in no way related to these, but probably by error. Ambrosia has also been published as a food plant, but in this instance *Boehmeria* had been mistaken for it.

The larva is sometimes destructive to hop vines, so much so that they have received a soubriquet in the farming districts, of which we have made use. "These chrysalids," says Smith, in a report to government (*Ent. bull. Dep. Agric.*, iv : 40) "are known to growers and those engaged in hop-yards as 'hop-merchants,' and according as the color of the metallic spots [on the back] is golden or silver, so will the price of hops range high or low, so the story goes." It is also applied to *P. interrogationis*.

Habits of the caterpillar. Although the egg at the summit of a column is the last of the series to be laid, it hatches first and the rest generally follow in succession, there being a difference of many hours; all the caterpillars emerge on the same side of the column, and as they escape from the crown of the egg, the column when emptied (for they do not eat more than is necessary to escape) has a gentle curve, tipped slightly in one direction by the escaping caterpillar. Immediately it is out of the egg, the caterpillar is long enough to coil twice around the interior of the egg, yet was coiled but once! Sometimes, after eating a hole large enough to escape from the egg, the caterpillar will rest motionless for a couple of hours. The great point is to get the head out; that done, the rest glides smoothly enough, toppling the column overhead. I watched once the last one of a column make his entrance into the world; first he took a grand tour of his old home, spinning a thread (as they always do when young) all the way; then he walked to the top of the leaning, tottering tower, peered over into the empty crater of the egg at the summit, shuddered visibly, and turned cautiously on his course, now with winding and then with direct steps, until he reached the lowest egg, when he stretched himself to the utmost and fastened a thread to the leaf beyond, to which he then travelled. An hour was consumed in this performance. In early life the caterpillars eat little roundish holes in the middle of one side of the leaf, about 1.5 mm. in mean diameter, and when their meal is over rest with their tails close to the hole, their heads toward the midrib.

Although a number are usually born on the same leaf and several in one cluster, and, therefore, for at least a part of its life, it does not lack companions, this caterpillar is in no way social, but strictly solitary from birth on. In early life it lives without concealment, but on the under surface of the leaf. Later it may be found "concealing itself on the under side of a leaf, the outer edges of which are drawn together by silken threads sufficiently to afford a protection from light and the weather; from this cover the larva emerges at night to feed, and beginning at the extremity of a leaf consumes it evenly across until not enough is left for shelter, when it

betakes itself to another and repeats the same process. Owing to this peculiarity, this species is easily discovered, as the bent and eaten leaf betrays its presence" (Edwards). Mr. Edwards found that it first sheltered itself very shortly after reaching its third larval stage, and that it effected its object by biting off the principal ribs of the base of a leaf, on either side of a midrib, after the manner of *Vanessa atalanta*, and was thus the better able to pull the sides of the leaf together. But in the later stages the ribs were not bitten, the caterpillar being able to draw the edges together without that precaution. His observations were made on *Boehmeria*; with the elm, a more refractory leaf, the process is slightly different (81:9); the caterpillar bites a couple of channels on either side the leaf, starting from a centimetre's distance from the base and cutting obliquely toward but not to the midrib, through two or more of the ribs; the corners of the flaps thus formed of the larger part of the leaf are then fastened together by a few strands of weak silk, rarely extending more than a centimetre and a half beyond the corner. The rest, therefore, flares open apically, and when half eaten bears some resemblance to a saddle. In these nests one never finds more than a single inhabitant.

Life history. In New England the insect is double-brooded. The butterflies hibernate and appear upon the wing all through the months of March, April and the greater part of May, occasionally into June, few in number and generally worn and faded; they lay their eggs on the tender leaves of the hop and elm soon after their budding; the eggs hatch in four or five days; the caterpillars grow rather slowly, the chrysalis state continues from seven to eleven days, and they begin to transform to butterflies toward the end of June; they do not become abundant until the beginning of July, and a few stragglers emerge from the chrysalis as late as the middle of the month. These fly throughout August and later. The eggs are again laid late in July and throughout August, and the second brood begins to appear about the 25th of August; they continue to emerge from the chrysalis until the latter part of September, and evidently hibernate without much delay, as they become scarce by the end of the month and are rarely seen in October. In one instance some late caterpillars I found in Cambridge on nettle changed to chrysalis as late as October 9, and the butterfly appeared October 27.

The butterflies of the first brood (i.e., first from eggs of the same season) are almost always of the form *dryas*, and those of the second, which winter, are of the form *harrisii*, but not invariably. For instance, Mr. Lintner took both forms on July 24, when only *dryas* should be flying, and I have several times taken wintered *dryas* on the wing about Boston the first week in June, and as late as the 19th, and Mr. F. H. Sprague has reared *dryas* (one out of more than fifty) from caterpillars found in

August. As a general rule, however, the spring form is *dryas*, the autumn form *harrisii*.

Further south, the species is triple-brooded. "The hibernating females deposit their eggs last of April or early in May, and the first brood of the butterflies emerges from chrysalis about 1st June; but should the weather be cold during May then from the middle to last of June. The second laying of eggs occurs in July, between 15th and 30th, and the butterflies from these appear last of August or first of September. And the third laying occurs in September, the butterflies therefrom emerging in October" (Edwards). The first brood is composed of *dryas* only "with a single exception when one *harrisii* male emerged"; the second of both forms, and the third of *harrisii* only.

Habits, flight, etc. They are very wary insects with a quick, nervous flight, yet at the same time audacious even to pugnacity, darting recklessly at and about objects in the air, vainly pursuing even passing birds or dragon flies, and tussling with each other to such an extent that their wings are almost invariably rubbed and ragged in a short time after eclosion. "The most perverse disregard of all measures of safety," says De Garmo, is exhibited by comma.

This little butterfly usually takes his pastime toward sunset, when only now and then a patch of sunlight remains among the shadows of trees, especially upon some gate post or the trunk of a tree, or a sidewalk. When disturbed very roughly they will take a zizzag trip over a tree, or a house top, or a fence, and often without lighting anywhere, return to the old spot within six inches. Many times I have put my hand on the coveted spot and had the little *Grapta* light upon them. Sometimes they will light upon my hat or the net I hold in my hand, evidently entirely unconscious of danger. But motion, even of a straw, will frighten them away. This peculiarity in their sense of danger is easily explicable. The enemies most deadly to them are the birds. These attack mostly from above, and always on the wing. They use no caution in securing their prey, but swoop down upon them at great velocity. In all my watching I have never seen a bird take a butterfly from beneath. The pewee will either drop like lightning from its branch upon the prey, or if the prey is above it, will rise to an altitude above the prey and drop down upon it. Hence its knowledge of danger, or if you prefer it, its organized experience of danger, is all from above, and from something in rapid motion. From beneath, even when in a position on a pendulous flower or leaf to see perfectly, they can be approached with much greater ease and certainty of capture (Trans. Vass. Br. inst., ii: 130).

Again this writer says:—

Often the little comma will follow a much larger butterfly, perhaps the *aphrodite* or *idalia*, now under, now over it, in swift zizzag movements, as if enjoying it hugely, while receiving no attention from the larger specimen. Sometimes the comma will pursue, as if in sport, a beetle or a wasp,—in such cases keeping a good distance away, but continuing the pursuit for some rods. Once I saw a comma and an *alope* rising high in the air together, going over and over each other in sportive mood, when a pewee bird shot swiftly upon the *alope* and bore it off. The little comma folded its wings back to back, and in half the time I am taking to tell it, literally dropped to within two or three feet of the ground, recovered its wings and then hid in a thick evergreen tree close by. On following it, it seemed unhurt, but greatly alarmed, ceaselessly changing its position from limb to limb, and finally getting under a large limb, and remaining very nearly motionless (Trans. Vass. Br. inst., ii: 134).

A pair of them may often be seen perched at some distance apart, sunning themselves on a rock, stone wall, or dead and fallen branches; suddenly one quits its station, the other following instantaneously; as if electrified by a common impulse they dash at each other, dart hither and thither, whirl about, and then as suddenly whisk back, each to its own spot, twist about in a final flourish of satisfaction and quickly resume the gentle fanning of their wings. It "is extremely alert and restless, flying swiftly and for short distances only; it frequents the roads, especially in damp places, or collects in considerable numbers on the sides of the creeks or upon damp stones by the forest brooks, not in clusters, as is the habit with many butterflies, but scattered about in close neighborhood with wings outspread to receive the full benefit of the sun." (Edw. Butt. N. A.) In the Catskills it is found in company with *faunus*, on the Kanawha with *interrogationis*, but greatly outnumbering the latter, according to the same writer.

When resting, whether clinging beneath some horizontal surface, or perched head downward on a vertical support, the wings are closed back to back, the front pair brought well forward, so as to form an angle with the body of 135° , and to expose a deep notch between the wings fully half way to their base; the antennae are held like stiff rods on a line with the slightly lifted front part of the body and diverge about 20° . When resting at night, the clubs of the antennae are brought side by side barely in front of the wings, and the front wings are not thrust so far forward as at other times; but on any disturbance, such as a jar or the approach of a light, a match for instance at several inches distance, the front wings are instantly slipped forward to their usual position at other times.

When walking up a vertical surface, as seen in mounting a window pane, the wings, held in the same attitude, alternately shut and open through an angle varying from about 10° to 45° , the antennae divaricate about 100° , and the legs move in a curious order, occasionally varied by a short step disarranging it, as follows: first the middle leg of the right side, then that of the left side, followed by the hind leg of the left side and then that of the right.

Mr. Edwards gives the following account of the metamorphosis of this species in leaving the larval for the pupal stage:—

When about to transform it selects a convenient place, on the under side of a projecting rock, or of a fence rail, or of a weather board of the house, or the midrib of a hop-leaf, and having spun a little button of pale red silk fixes the hooks of its anal legs therein and hangs suspended, head downwards, in the shape of a fish-hook, and immovable, for the space of 20-24 hours, no change being perceptible except in the color of the skin which becomes partly transparent and loses its dark color, owing to its gradual parting from the chrysalis within. Suddenly, and to a looker on without any premonitory symptom, a rent takes place in the skin at the back of the head just wide enough to allow the passage of the chrysalis, the head of which at once emerges. By a rapid contraction and expansion of the folds of the abdomen, the larva draws the

skin upwards successively discovering the parts of the fully formed chrysalis, until at last, and in scarcely more than one minute of time, the entire skin is gathered about the anal feet. It now bends itself violently to disengage the end of the chrysalis, which is long, pointed and hard, furnished with several little hooks, meanwhile retaining its hold of the skin by the folds of its abdomen, until after a severe effort, convulsively reaching out and feeling in all directions for the object of its search, it touches the button of silk and at once grasps it with its hooks and fixes them in it securely. Then by a twisting motion it manages to disengage the loose skin, which falls to the ground, and the chrysalis rests. (Butt. N. Am., i.)

Experiments made by Mr. Edwards in the application of cold to the chrysalids of this species failed from the death of the subjects.

Parasites. I have never met with any hymenopterous parasites of the caterpillar and find none on special record, but Mr. J. B. Smith says that "not one in ten ever attains the butterfly state" on account of parasites, and adds of his autumn collections that "the chrysalids I collected were one and all infested." Mr. Howard informs me the parasites were the common *Pteromalus vanessae* (89:3). *Glypta erratica* Cress. (88:7) has also been found parasitic on this butterfly by Dr. Riley; and I once reared or had sent me a Tachinid fly and puparium raised from this species, but the fly has been lost.

Desiderata. The accounts of the northern range of this butterfly are so various, perhaps owing to its localization, that careful statements of its comparative abundance are needed from all parts of Canada and the north of New England, before its geographical distribution can be fully understood. The cause of its localization also needs investigation and more exact statistics are requisite in order to determine properly the history of the insect, especially the duration of its several stages and the question of its hibernation in the chrysalis state; but of most interest of all would be an enquiry into the precise relation of the two forms, *dryas* and *harrisii*, to the two broods; a great many further statistics on this point, made in different places, are highly desirable. What dipterous parasite has it?

LIST OF ILLUSTRATIONS.—POLYGONIA COMMA.

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| <p><i>Egg.</i></p> <p>Pl. 64, fig. 18. Plain.</p> <p>19, 20. Column of eggs.</p> <p><i>Caterpillar.</i></p> <p>Pl. 74, fig. 38. Side view, colored.</p> <p>78:36. Front view of head in final stage.</p> <p>81:9. Nest.</p> <p>86:67. Dermal appendage of body, stage i.</p> <p><i>Chrysalis.</i></p> <p>Pl. 83, fig. 27. Outline of head from in front.</p> <p>29, 30. Outline of mesothoracic tubercles.</p> <p>39, 46. Side view, colored.</p> <p>47. Side view, outline.</p> <p>48. Dorsal view, outline.</p> | <p><i>Imago.</i></p> <p>Pl. 3, fig. 1. <i>P. c. dryas</i> male, both surfaces.</p> <p>3. <i>P. c. harrisii</i> male, both surfaces.</p> <p>4. <i>P. c. dryas</i> female, lower surface.</p> <p>7. <i>P. c. harrisii</i> female, lower surface.</p> <p>33:14. Male abdominal appendages.</p> <p>38:10. Neurulation.</p> <p>61:19. <i>P. c. dryas</i>, outline hind wing.</p> <p>20. <i>P. c. harrisii</i>, outline hind wing.</p> <p><i>General.</i></p> <p>Pl. 20, fig. 2. Distribution in North America.</p> <p>88:7. <i>Glypta erratica</i>, a parasite.</p> <p>89:3. <i>Pteromalus vanessae</i>, a parasite.</p> |
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POLYGONIA SATYRUS.—The wandering comma.

Vanessa satyrus Streck., Cat. Am. macrolep., 131 (1878).

Grapta satyrus Edw., Rev. cat. diurn. Lep., 39 (1884).

POLYGONIA SATYRUS SATYRUS.

Grapta satyrus Edw., Trans. Am. ent. soc., ii: 374 (1869); Butt. N. A., i, pl. Grapta 6, figs. 1-4 (1872);—H. Edw., Pac. coast Lep., ii: 8-9 (1873).

Nymphalis satyrus Kirb., Syn. cat. Lep., 648 (1872).

Polygonia satyrus Scudd., Bull. Buff. soc. nat. sc., ii: 252 (1875).

POLYGONIA SATYRUS MARSYAS.

Grapta marsyas Edw., Trans. Am. ent. soc., iii: 16 (1870); Butt. N. A., ii, pl. Grapta 3, figs. 5-8 (1875).

Nymphalis marsyas Kirb., Syn. cat. Lep., 648 (1871).

Polygonia marsyas Scudd., Bull. Buff. soc. nat. sc., ii: 252 (1875).

Vanessa satyrus var. *marsyas* Streck., Cat. Am. macrolep., 131 (1878).

. Marsyas is unknown in the east, and is therefore not described below.

As when Zephyr bids
A little breeze to creep between the fans
Of careless butterflies.

KEATS.—*Endymion*.

Imago (14:1, 14). Head covered with long ferruginous and olivaceous hairs, the latter predominating along the middle, the former at the sides, mingled next the outer bases of the antennae with yellow hairs; behind the eyes a fringe of mingled ferruginous, dusky ferruginous and yellow scales. Sides of palpi pale buff on the basal half with scattered ferruginous hairs, the apical joint dark ferruginous, extending baseward in a tongue along the upper part of the middle joint as far as the eye, the upper edge nevertheless buff, and a line along the inferior edge of the fringe ferruginous; antennae black-brown above, feebly flecked with scattered, dull, pale scales, naked and testaceous along the inner side, beneath white in triangular patches, as long as the joints, having their apices at the tips, or only on basal half, the apical black-brown; club black-brown above, more abundantly and distinctly flecked with yellow, white and ferruginous scales, within and beneath naked, bright castaneous, all of the last three joints naked, luteous. Tongue luteous at base, with the sides infuscated, beyond blackish laterally.

Thorax covered above with silky olivaceous and greenish-gray hairs, beneath with mingled yellowish white and pale ferruginous hairs, the latter predominating. Fore legs with similar hairs, but also clothed with velvety black scales down the middle, and with pale buff and silvery white scales on the sides; other femora heavily clothed with mingled tawny and dark ferruginous scales, flecked with pale scales of various tints, and especially often fringed with a line of yellow scales along the lower inner edge; tibiae and tarsi uniform pale buff. Spines, spurs and claws castaneous, the last deepest; paronychiae pale castaneous; pulvillus black.

Wings above rather light fulvous orange, deepening toward the base, marked with black and fuscous or fusco-ferruginous. Fore wings with the upper portion of the outer border slightly concave, the subcostal dentation distinctly less than rectangular, that at the tip of the lower median nervule hardly less prominent, sometimes not more than rectangular, the whole outer margin distinctly crenulate. The costal edge is indistinctly yellow, rather inconspicuously interrupted with black on the basal half. In the cell and the interspaces below it are black spots, which exactly repeat those of *P. comma*, excepting those of the lower median interspace, the outer of which is usually rectangular in form, and the inner, at the extreme base, larger and more distinct than in *comma*, where it often is almost absent; here it is sometimes almost as large as that below it. The outer dark margin is precisely as in *comma*, excepting that it is nearly obscured by grayish below the lower median nervule, or at least below the middle of the medio-submedian interspace. The markings at the apex of the wings, within the dark border, are also exactly as in *comma*, excepting that the

band depending from the costa, midway between the apex of the cell and the tip of the wing, is darker ferruginous, decidedly fuscous or even blackish. On the lower half of the wing there are sometimes no markings just within the border, excepting a dusky, more or less ferruginous, triangular spot with blurred edges, in the middle of the outer half of the medio-submedian interspace, and faint triangular lunules seated on the dark margin, scarcely paler than the ground; but these lunules are usually distinctly paler, and following them on the inner side there are often some deep ferruginous fleckings, forming, with the dusky spot below, a ferruginous cloud. Toward the base of the wing the orange becomes much deeper and warmer, and at the extreme base is somewhat infuscated; along the lower margin it is more or less obscured by grayish fuscous; fringe as in comma. *Hind wings* with the outer border considerably crenulate, the dentation of the upper median nervule twice as long as broad, scarcely tapering, rounded at the tip, especially at the upper corner; the costal projection considerable, strongly rounded; the upper subcostal rectangular. Three distinct black spots in the basal half of the wing; one an oblique, transverse bar depending from the middle of the costa and reaching the middle subcostal nervule, followed above by a slightly paler tint to the wing; an obliquely transverse bar at the extreme base of the lower subcostal and upper half of the subcosto-median interspace, parallel to the first, and with its outer margin sometimes almost continuous with the inner margin of the first, but ordinarily removed inward by half its width; the third a triangular patch at the extreme base of the upper median interspace, occasionally followed toward the base by an obscure grimy extension which loses itself in the considerable infuscation of the base of the wing. The outer margin of the wing has a dark border of the same width as that of the costal margin, deepest within, but not nearly so dark as on the fore wings, being fusco-ferruginous at darkest and sometimes merely ferruginous, its outer half more or less obscured by gray or pale tawny; it is followed within, in the heaviest marked specimens, by a similar but more cloudy belt united with it at the costal extremity and separated from it by a series of laterally connected, ill-defined, pale lunules, generally clearer than the ground color of the wing, sometimes reduced to small, pale spots, roundish in the upper, transverse in the lower half of the wing; fringe much as in fore wing.

Beneath, varying from dark to light brown on the basal half, more or less ashen gray, especially in the ♂, on the outer half, the whole often tinged strongly in the ♂ with dull olivaceous. *Fore wings* with the position of the markings and their general tone and value precisely as in comma (the sexes differing also as there), excepting that the linear streaks in the cell are more decidedly longitudinal, almost completely parallel to the subcostal nervure, with scarcely any obliquity, the lower of the two outer ones unmarginated and independent, often obscure, and nearly twice as long as the others. The same is true of the *hind wings*, including the central silvery comma, the only distinction lying in the less vivid variegation of the colours in satyrus. the more distinctly black-edged margin of the basal field and in the ♂ the more frequent and pervading yellow ground tints.

Abdomen above black with tawny scales and hairs; beneath of the prevailing tone of the under surface of the wings. Appendages of the male (33:32): upper organ exactly as in comma; clasps fully twice as broad as long, broadest below, the angles well rounded, the upper posterior angle produced to a small, triangular, incurved lobe, almost pointed at the tip; basal process of upper margin very similar to that of comma but its apical half bent downward at a stronger angle.

Measurements in millimeters.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	22.	26.	27.5	26.		28.
antennae		14.6				14.
hind tibiae and tarsi..	7.5	9.3	9.25	9.		8.75
fore tibiae and tarsi..	3.75	.5	.5	3.5		4.5

Described from 5♂ 2♀.

Suffused variety (*Grapta marsyas* var. Edw., Butt. N. A., ii, pl. Grapta 3, figs. 5, 6). Mr. Edwards figures a suffused example raised by Mr. Baron, of Navarro, Cal. The upper surface shows all the dark spots of the disc of the wings run together and beclouded, that on the front wings with a central fulvous patch; while the dark margin is broadened and also beclouded, at least on the front wings. Beneath, the front wings have a very broad, paler band parallel to the general course of the outer margin, and more or less shot with smoky brown, and darker parts beyond the bands, deepest next the band, as the band is also lightest on the margins. The hind wings are almost uniform with faint marbling and broadly infuscated veins, the transverse streaks being quite obliterated. The discal silvery spot is normal.

Caterpillar. *Last stage* (74:33). Head black, angular, with a spiny tubercle at each of the upper angles; body black, with a broad, greenish white, dorsal stripe, which on the anterior segments is clouded with black; on each segment, on this stripe, is a fine V-shaped, black mark, having its angle at the dorsal spine; an infrastigmatal greenish white line. Dorsal, laterodorsal, and infrastigmatal spines greenish white; laterostigmatal spines black; the spinules of all the spines concolorous, excepting that those near the tip of the pale spines are blackish (adapted from Stretch).

Mr. H. Edwards found in California little variation in the caterpillar, "the markings . . . being remarkably constant in every instance." Mr. Mead, on the contrary, found much variation in Colorado.

Chrysalis (83:41, 42). "Fawn colored, with a few darker markings irregularly placed" (H. Edwards), especially next the inner margins of the wing covers, and on the abdomen; the base of the wings is sometimes obscurely darker than the tip. The two separated by an oblique line extending from the apical wing tubercle to the middle of the antennae, the surface being slightly angulated along this line; on the abdomen, a distinct, dark, sometimes black, stigmatal band, bounded above by the upper edges of the stigmata, below by the infrastigmatal tubercles, darkest below and in its continuation on the sides of the cremaster; a slender, clearer, dorsal line, and from the fourth segment backward a series of clouded oblique stripes from the laterodorsal tubercles backward and inward; the tips of these tubercles and all the suprastigmatal series paler than the ground; the metathoracic and first two abdominal tubercles of the laterodorsal series "silver, the posterior with a trace of gold" (H. Edwards); mesonotal tubercle high, compressed, fully as high as broad, nearly as high anteriorly as posteriorly, and shaped generally much as in *interrogationis*. Fourth abdominal laterodorsal tubercles regularly conical, about as high as broad, much larger than the others. Ocellar tubercles conical, the curve of their separation exactly as in *interrogationis*. Length, 21 mm; height at mesonotal tubercle, 8.5 mm.

Distribution (20:1). The home of this butterfly is in the west, where it ranges through the Cordilleras from Crow's Nest (Geddes) in the north to New Mexico (Edwards) in the south, and from the eastern foothills,—Clear Creek and Platte Canons, Col. (Snow)—to the Pacific; along this coast it is recorded from Santa Clara Co. (Stretch) and Mendocino Co., Cal. (Baron, Butler) to Oregon and San Juan and Vancouver's Islands (H. Edwards). Within recent years it has been discovered also in the east, first by T. L. Mead, who recognized it at sight from his acquaintance with it in Colorado, and who captured a pair of specimens (the only ones seen in a month's collecting) in July, 1874, at Cameron Lake, a little north of Port Hope, Ont.; next a couple were raised by C. W. Pearson in June, 1875, from caterpillars taken at Chateauguay Basin, fifteen miles south of Montreal, where J. G. Jack has since taken a specimen; Mr. Fletcher has also found it at Ottawa, and lastly a single

male was found by W. W. Hill at Fentons, Lewis Co., N. Y. in August, 1876. No additional captures have been reported within the last ten years. Doubtless it must occur in much of the intervening region, probably along the north shore of Lake Superior and the southern boundary of the Dominion of Canada.

Its discovery by Mr. Pearson is the only warrant for its introduction at this place. It will probably be found within the territorial limits of New England.

Food plant. The caterpillar feeds on the stinging nettle, on which it has been found both on the Pacific coast (Stretch, H. Edwards) and in Canada (Pearson). Mr. W. H. Edwards writes that it has also been taken on Azalea. Mr. Edwards has shown me a drawing by Mr. Barus indicating that the caterpillar draws the leaves of nettle together as *P. comma* does, and probably by the same methods.

History, etc. The data for any history of this insect are very meagre. We only know that the caterpillar is to be found in June, the butterfly in July, and that the chrysalis state lasts at this season about a fortnight, the caterpillars reared by Mr. H. Edwards on the Pacific coast changing to chrysalids between June 20 and 26, and emerging July 4-18; while the caterpillars obtained by Mr. Pearson near Montreal, changed July 1, and the butterflies emerged July 13-15. The only dates of capture of the butterfly are April 2 in California (Osten Sacken), June 24 in Colorado (Mead), July 9 and 21 in Utah (Putnam, Packard), July 22 in Ontario (Mead) and August 1 in New York (Hill). Whether the insect is single or double brooded is therefore altogether uncertain, the absence of dates of a second brood in no way disproving it, since the butterfly must certainly be on the wing at the season at which a second brood should appear. The butterfly undoubtedly hibernates, as Osten Sacken's capture shows. The dimorphism of the species was suggested by me as "very likely" in 1875, and proven by the breeding experiments of Mr. O. T. Baron of California (Edw. Butt. N. A., ii. Grapta 3 p. [4]). Mr. Edwards had urged against it that the two forms did not fly over the same territory, and indeed until now *P. s. marsyas* is known only from the Pacific coast. No account has therefore been given of it here, as it is not impossible that it is confined to that region. The butterfly flies in company with its congeners, in the west with *silenus*, in the east with *progne* and *faunus*. The only notice of its flight is by Mr. Mead, who says his Ontario specimens were taken at a patch of milk-weed, and that after the first was secured the other was very wild, "frequently flying far into the woods, and then after a few moments returning to the patch of milk-weeds."

Pteromalus puparum (89: 1, 2.) has been raised from this insect, according to Mr. W. H. Edwards.

Desiderata. In New England search should be made for this butterfly

in the north. It is especially probably that it will be found in the White Mountain district. The history of the butterfly after July is an absolute blank at present, and we know nothing of the egg, or the larval habits, and scarcely anything of any distinctive peculiarities of the butterfly. A knowledge of its range in the middle of North America (north of our line, probably) is highly desirable.

LIST OF ILLUSTRATIONS.—*POLYGONIA SATYRUS*.

<i>Caterpillar.</i>		<i>Imago.</i>	
Plate 74, fig. 33.	Mostly dorsal view.	Plate 14, fig. 1.	Male, both surfaces.
	<i>Chrysalis.</i>	14.	Female, under surface.
Plate 83, fig. 41.	Side view.	33:32.	Male, abdominal appendages.
42.	Front view in outline.		<i>General.</i>
		Plate 20, fig. 1.	Distribution in North America.

GROUP II (progne).

Antennae usually with 38 joints (faunus 41); subcostal dentation of margin of hind wings very prominent. Eggs generally laid singly on upper surfaces of leaves. Markings of caterpillars generally disposed in dorsal masses or blotches; always living solitary and exposed on under surfaces of leaves. Chrysalis with ocellar tubercles subcylindrical, obliquely truncate, the laterodorsal tubercles of fourth abdominal segment not strikingly larger than the others.

SPECIES: *faunus*, *gracilis*, *progne*.

POLYGONIA FAUNUS.—The green comma.

[The green comma (Gosse); the cinnamon butterfly (Ross); green-banded comma butterfly (Maynard)].

Grapta faunus Edw., Proc. Acad. nat. sc. Philad., 1862: 222-223 (1862); Proc. Entom. soc. Philad., i: 182-184 (1862); Butt. N. A., i. Grapta 1, figs. 1-4 (1870); Can. ent., xix: 3-4 (1887);—Lintn., Proc. Entom. soc. Philad., iii: 57 (1864);—Caulf., Can. ent., vii: 49-50 (1875);—French, Rep. ins. Ill., vii: 152 (1878); Butt. east. U. S., 187-188, fig. 52 (1886);—Middl., Rep. ins. Ill., x: 84 (1881);—Fern., Butt. Me., 54-55, figs. 17-18 (1884);—Mayn., Butt. N. E., 13, pl. 2, figs. 14, 14a (1886).

Vanessa faunus Kirb., Syn. catal. Lep., 182 (1871).

Nymphalis faunus Kirb., Syn. catal. Lep., 648 (1871).

Polygonia faunus Scudd., Syst. rev. Amer. butt., 10 (1872); Butt., 136-137, figs. 54, 126 (1881).

Grapta progne? Gosse, Can. nat., 96, 278 (1840).

Grapta c-argenteum Belt, Trans. Nova Sc. inst. nat. sc., ii: 90-91 (1868?).

Vanessa c-album Streck., Cat. Am. macrolep., 129-130 (1878).

Papilio — Abb., Draw. ins. Ga. Brit. mus., vi: 39, fig. 9.

Figured by Glover, Ill. N. A. Lep., pl. 38, fig. 12, ined.

[Not Pap. progne Cram., nor *Grapta c-argenteum* Kirb., nor Pap. *c-album* Linn.]

Voici le papillon Faune
Noir et jaune.

GERARD DE NERVAL.

Imago (3:2, 6; 14:3). Head covered above behind the antennae with olivaceous hairs; in front with mingled black, whitish and dusky ferruginous ones; outside of the base of the antennae a slight tuft of yellowish white hairs; the sides of the head behind the eye with mingled whitish, very pale olivaceous and dusky scales; palpi on basal half of outer side dull white, very prettily variegated with scattered black and dark ferruginous scales, the latter becoming more frequent toward the middle and

almost exclusively filling the apical half of the palpus, sometimes and especially in the ♂ so strongly infuscated as to be nearly black; the superior fringe of the middle joint is blackish, white at the apex; the inferior fringe is white, but beneath exteriorly there is a line of black scales which surpass the white ones a little; the long, scattered hairs on the sides of the palpus are ferruginous. Antennae blackish above, naked and luteous beneath inwardly; exteriorly with a narrow, continuous stripe of pure white, expanding toward the upper surface on the basal half of each joint; club similar to the stalk, but more or less flecked with white at the base, beneath much infuscated and with the apical 2-4 joints more or less conspicuously luteous, though sometimes somewhat infuscated at their bases. Tongue luteo-fuscous, luteous at base and tip, the sides everywhere blackish, excepting at tip.

Thorax covered above with greenish tawny hairs, beneath with hoary tipped, brownish, vinous hairs, with a few intermingled hoary ones. Fore legs with a broad, black stripe down the front, narrowly edged on the outer side and occasionally a very little on the inner with whitish or very pale yellowish; the lateral fringe of mingled hoary and vinous hairs; femora of other legs blackish, conspicuously flecked, especially on the upper half, with whitish or yellowish scales, just before the extreme tip annulate with yellowish; rest of legs very pale buff or pale clay brown, the extreme base of tibiae slightly blackish at base; spines dark castaneous, darkest on the tibiae; spurs luteo-castaneous, becoming dark reddish at tip; claws and paronychiae nearly uniform dark castaneous, the former blackish at tip; pulvillus black.

Wings above bright fulvous orange, considerably tinged, especially on basal half, with cinnamonaceous in the ♂, paler and washed with ochraceous in the ♀. *Fore wings* with the upper portion of the outer border slightly concave, the dentation nearly rectangular; that at tip of lower median nervule rather prominent, well rounded; outer margin strongly crenulate. The dark markings of the fore wings are located precisely as in *P. comma*, but they are sometimes a little heavier, the two spots in the cell generally touch each other and are sometimes slightly blended; the darker markings of the outer half of the wing are tinged more or less distinctly with a dark maroon brown, often slightly obscured by a cinnamonaceous or ruddy hue; the extreme outer border, especially in the female, is usually very narrowly edged with a grayish bloom of dull, pale, dingy, greenish scales; fringe blackish brown, interrupted broadly with white in the interspaces. *Hind wings* (61:21) with the costal border more sinuate than in the other species, the outer border strongly crenulate, the tail of the upper median nervule somewhat longer than broad, broader at tip than at base; the projection at the tip of the upper subcostal nervule large and broad, including the middle subcostal nervule, crenulate at tip; that at the lower angle quite large and well rounded. The costal border as far as the subcostal nervule mostly griseous, a dusky, blackish, quadrate spot crossing the middle of the interspace, often obscured by the general tint; the basal two-sevenths of the upper subcostal interspace occupied by a black spot, having a straight exterior border, at the very base of the interspace sometimes griseous or even slightly ferruginous; another transverse, subovate, black spot occupies the upper half of the nervule closing the cell and the nervules above as far as the subcostal nervule; it is generally narrower and sometimes obscure above; the bases of the two median interspaces are occupied by black, the upper one always distinctly, the lower sometimes obscurely, and without reaching so far toward the border of the wing; in the upper median interspace the patch is about one-half as long as broad; the outer border of the wing is margined broadly like the fore wings with blackish ferruginous, deepening sometimes into black and limited by a transverse series of rather small, irregular, roundish, dull ochraceous spots, but the dark color extends also continuously past these spots, becoming more and more ferruginous but still dusky as far again toward the base of the wing, where it terminates in a vaguely defined line subparallel to the outer border; the extreme outer border is edged, rather more broadly than in the fore wings, and more distinctly in the ♀ than in the ♂, with a grayish bloom, in which the scales are more brightly tinged and occasionally enlivened with tawny. Fringe much as in the fore wings.

Beneath, grayish brown, greatly variegated, more so than in any other species of *Polygonia*. The basal half of the *fore wings* is a little darker than the apical half, and at its outer limit becomes developed—always in the ♂, usually in the ♀,—into a much darker colored mesial band whose exterior border only has a definite outline; this passes from a little beyond the tip of the costal nervure in a shallow curve, opening outward, to the base of the straight portion of the upper median nervule, just previous to reaching which it is generally blurred; from this point it crosses the upper median interspace in a straight line and then passes in another shallow curve, opening outward and backward, and sometimes interrupted at the nervules, to a little before the middle of the inner margin; the band is black next this exterior margin but speedily becomes dark, fuliginous brown; above the cell the band has also a distinct interior margin, striking the subcostal nervure at the base of its second branch, and is followed interiorly by an ashen patch becoming brownish yellow in the cell; in the cell are three brownish plumbeous, oblique streaks, the basal one black edged, parallel to the subcostal nervure, resting upon the median nervure close to the base and directed toward the second, which is slightly arcuate, on a line with the previous but always separated from it by a little space, depending from the subcostal nervure, just within its first divarication; the third, edged with black only occasionally or partially, is seated upon the median nervure just within its first divarication and has its inner edge on a line with the outer edge of the second, with which it becomes sometimes partially confluent and often has its outer border more or less blended in the mesial band; from the first inferior subcostal to the lower median nervule there is a submarginal series of black lunules, which have become so blended as, on account of the excision of the wing, to form one continuous lunule with crenulate interior border, broadest in the upper median interspace and diminishing toward either end, which is very largely filled with rather pale, dull green, scarcely connected lunules; connected with this series there is a double, greenish spot in the medio-submedian interspace edged on all sides with black; and in the two subcostal interspaces succeeding it above are slight greenish spots, edged interiorly with black arrow-heads, and without with a few cinnamoneous scales; outside the connected lunules the border of the wing is dusky, considerably variegated, especially in the two middle interspaces, with ochraceous next the margin, and with whitish next the lunules; above the first inferior subcostal nervule the apex of the wing is filled by a quadrate patch of ochraceous, tinged, especially inwardly, with dusky ferruginous, the upper interspace having a ferruginous arrow-head in continuation of those in the interspaces beneath; following this and the black lunules is a slender, obscure, whitish stripe nearly obliterated in the middle of the wing, but moderately conspicuous toward either border, and which is crossed by a pretty strongly sinuous series of pale green, roundish spots, edged to a greater or less extent on the exterior half, and occasionally entirely, with black scales; above the lowest subcostal nervure they follow the white stripe exteriorly; below it they follow it interiorly; by far the largest of them is in the medio-submedian interspace, where it reaches from nervule to nervule, and is followed interiorly by a hoary cloud of nearly the same size; those in the lower median and lower subcostal interspaces are of about the same size, the former about one-third of the width of its interspace; the rest are smaller, and that in the upper median reduced to a black dot; the rest of the outer half of the wing is of a varying dull, pale, yellowish brown, transversely streaked by short threads of dusky ferruginous, more frequent, shorter and indistinct in the subcostal area, more distant and pronounced in the median area; above the middle of the lowest subcostal interspace is a large quadrate patch of ashy lilaceous, in about the centre of which occurs the last divarication of the subcostal nervure; within this patch, and as far as the mesial band, the wing is again a little paler. Fringe black at the nervure tips, with intermingled cinnamoneous scales at the apex, broadly interrupted with white in the interspaces. *Hind wings* similar to the fore wings in the color and general disposition of the markings; the darker basal half is separated from the outer portion by a sinuous, black line which follows the same course as in comma; midway between it and the origin of the precostal is a transverse black line which, above the costal, is a little further removed from the base than

in the costo-subcostal interspace, which it crosses with a shallow curve opening inward, and strikes the subcostal at its first divarication; within this the wing is crossed infrequently by short, straight, transverse, blackish threads; the tip of the cell is marked by a heavy silver C similar to that in comma, but generally more angular; above, this fails of reaching the subcostal nervules and at its extremity has a slight pointed tooth directed outward, and at the outer extremity of its outer lobe, which seldom tapers, it is usually thickened and then generally emits a similar tooth directed toward the upper one, causing it sometimes to resemble rather a G than a C; it is sometimes as broad as the tarsi and always approaches that size; occasionally it is reduced to an L precisely resembling that of its companion form gracilis; there is a heavy, submarginal series of nearly or quite connected, dull green lunules, closely following the variations in the curve of the outer border, even including its strongest dentations, and distant from it by nearly an interspace's width, distinctly edged within and without with black, followed within by pale, ashy gray, sublunate, rather smaller spots, and shortly afterwards by a slightly sinuous series of moderately large, roundish, dull green spots, as far from the submarginal series as it is from the outer border, narrowly edged with black, and this by a similar, blurred, pale ring, and this, inwardly at least and broadly, by a fuscous cloud; the series extend from the inner border to the upper subcostal nervule, the submarginal lunule of the costo-subcostal interspace being continuous with it; the uppermost spot and the submarginal lunule of the costo-subcostal interspace are followed interiorly by a slightly ashy or hoary cloud, and over the rest of the outer half of the wing are scattered short, inconspicuous threads of dusky ferruginous; the outer margin beyond the lunules is variegated with black and white and an admixture of a few scales of a lively color, and next the very border is tinged strongly, but least so in the middle of the border, with dull, brownish ochraceous; fringe of mingled black and tawny scales interrupted with white on the interspaces. The ♀ differs in the coloration of the under surface of both wings in having all the contrasting colors subdued, sometimes but slightly, so as scarcely to be distinguished at first sight from the ♂, at others so greatly as to make them appear confused and blended into a dull brown; the C shaped mark of the centre of the hind wings is also slenderer and sometimes even faint.

Abdomen above black, heavily covered with tawny scales; beneath of a dull, grayish brown in which some yellowish and vinous tints occur. Male appendages (33:16): upper organ; hook as in comma, but more curved and at base depressed, as long as the body with a smaller basal tooth. Clasps strongly arcuate as viewed from behind, giving them a smaller appearance than usual, but really twice as broad as long, the upper portion of the hinder edge bent over inward to form a small, inconspicuous, triangular, rounded lobe; basal process of upper edge bent and twisted at the extreme base so as to be horizontal and depressed, curving inwards and a very little downwards in passing backward, crossing each other, very much larger than the clasp, slender and tapering throughout, but most so by the sloping of the outer edge of the apical fourth; apex pointed: interior finger long and slender, equal, pointed, arcuate, traversing the clasp a little beyond the middle.

Measurements in millimetres. Length of tongue 11 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	21.75	25.5	26.5	25.5	27.	28.25
antennae.....	11.5	14.	14.4	13.25	14.2	14.65
hind tibiae and tarsi..	7.6	8.5	8.9	8.25	8.75	8.6
fore tibiae and tarsi..	3.75	4.2	4.5	4.15	4.45	4.25
upper median nervure of hind wing.....	10.8	12.25	12.8	12.	13.2	13.75

Described from 60 ♂ 12 ♀.

Egg (64:21). Grass green, of equal height and breadth, with from ten to thirteen, usually eleven or twelve, vertical ribs running from extreme base to extreme summit, and increasing very gradually in height in passing upward; they are strongly com-

pressed, very thin, and have a beaded appearance from apparent indentations where the cross lines strike them; these are very faint, scarcely elevated and about .03 mm. apart. The micropyle basin is not depressed but only indicated by the termination of the vertical ribs and is about .2 mm. in diameter: it is composed (67:10) of a central circle, around which radiate eight or nine kite-shaped cells, surrounded at first by irregular and then by pretty regular pentagonal or hexagonal cells growing constantly larger. Height of egg, .85 mm.

Caterpillar. *First stage* (70:28). Head (78:42) shining olivaceous green, piceous by some reflected lights, its appendages concolorous, the hairs black. Body pale green, more or less hoary in the creases, the abdominal segments more or less brownish, especially above. Papillae a darker green than the rest of the body, the hairs black, very long, some being nearly twice as long as the diameter of the body, curving or sinuate, and erect, the curves generally forward or upward. Legs fuscous; prolegs color of body but apically tipped externally with blackish; spiracles black. Length, 2.25 mm.; of longest hair, .62 mm.; breadth of head, .55 mm.

Second stage. Head (78:43) piceous. Body dark olivaceous green, much infuscated. A pale, slender, wavy, substigmatal line, from which on the abdominal segments spring similarly slender, pale, oblique lines, two to a segment, running obliquely backward from each side of the spine; a narrow, subdorsal band made up of transverse pale lines, narrowing posteriorly, and sometimes nearly or quite confluent on the two sides; a pale annulus around the base of the laterodorsal spines on the thoracic segments, sometimes faintly connected on successive segments by lines running from the upper and lower edges backward. Spines as high as the length of the segments, black, excepting those of the second, fourth and sixth abdominal segments, which are entirely white, including the mamillate base, but excluding the spinules, which are black as elsewhere; apical spinules about as long as the spines, curved, and in the middle somewhat bent, the others nearly as long as the spines and straight. Legs black; prolegs of the color of the body but blackish exteriorly. Length, .5 mm.; breadth of head, .8 mm.

Third stage. Head (78:44), bronze-black; most of its high tubercles black, but those at back of head and two conspicuous ones at front base of coronal spines white; most of the hairs are black, but those of the two tubercles just specified are white, as are the apical hairs of coronal spines. Body purplish brown with a greenish tinge, much marked with white in short, transverse, white streaks in dorsal region, especially about the dorsal and laterodorsal spines; marked also by an irregular, slender, infrastigmatal line, from which, on the abdominal segments, arise oblique white lines crossing the segments. Spines and spinules black, excepting those of the dorsal, and laterodorsal series on the second, fourth and sixth abdominal segments, sometimes also the laterodorsal ones of second and third thoracic segments and the infrastigmatal ones of fourth, sixth and ninth abdominal segments, which, but rarely their spinules, are pellucid white, occasionally tinged at base with orange; sometimes also the slender apical half of the other abdominal tubercles of the dorsal and laterodorsal spines are white; spiracles black with a pale or white annulus. Length, 8-10 mm.; breadth of head, 1.4 mm.

Fourth stage. In this stage the head (78:45) is as before, with the coronal tubercle larger. In the body the upper surface is divided between an anterior pale, dirty orange field, including the thoracic and two abdominal segments, and a posterior hoary field made by heavy paraffine-white markings, mostly longitudinally disposed, on a black ground. Most of the dorsal, subdorsal and laterodorsal spines and spinules are white, but fuliginous on the third, fifth, seventh, eighth and ninth abdominal segments, while the bristles are always black. The sides of the body are black, marked by a double, chain-like, stigmatal stripe of orange, in the upper line of which the piceous bases of the suprastigmatal spines are situate. Spiracles black, with a luteo-fuscous anaeole. Length, 17 mm.; breadth of head, 1.9 mm.

Fifth stage (74:32). Head (78:46), black, with a pale, dull luteous W on the front, the middle bars following the suture of the frontal triangle, the outer terminating at

the front base of the crowning thorns; whole head covered with scattered, pale warts, each giving rise to a long, tapering, pale, brownish yellow hair; next the neck the head is mottled with dull luteous; crowning thorns black, as well as their spinules, their hairs like the rest of the hairs on the head. Mouth parts brownish fuscous.

Body dull brownish yellow in great part, especially on the sides; the dorsal surface, as far as and including the laterodorsal spines, is paler, and on the third to eighth abdominal segments white, in certain lights snowy white, but generally dull, and always forming a striking contrast to the other portions; hinder part of body above blackish; on the sides of the abdominal segments there is a double, chain-like, dull orange band, the spiracles seated in black spots occupying alternate links; frequent slender, dusky or black transverse lines alternating with pale brown or whitish lines are found on the front and rear of each segment, least conspicuous above; on the side of each segment, most conspicuous on the abdominal ones, are three velvety black spots, one, already mentioned, enclosing the spiracle, longitudinally obovate, another, the most conspicuous, on the anterior halves of the segments, occupying the space between the laterodorsal and suprastigmatal spines, longitudinally or a little obliquely sublunate; the third, smallest, consisting of an oblique dash, separated from the sublunate spot by an oblique white streak, running forward and curving a little downward from the laterodorsal spine. Beneath, the body is dark grayish brown with numerous blackish fuscous, transverse lines and dots, and encircling the prolegs wreaths of dusky or blackish blotches; outside of the prolegs wholly blackish, paler at tip; spines (86:82) all white, with whitish spinules and whitish, occasionally a little dusky, needles, with the exception of all the spines above the stigmatal line on thoracic and first and second abdominal segments, which are pale brownish yellow, a little paler than the ground color; legs black; claws luteous; spiracles black, encircled by livid in a black field. Length, 30 mm.; breadth of body, 4 mm.; of head, 2.85 mm.; length of head spines, 1.25 mm.; of body spines, 2.15 mm.

It differs from *P. comma* in the possession of a W on the front of the head and in lacking the ferruginous spots on the body; and from *P. progne* and *P. c-album* of Europe, in not having a pale, supraorbital band on the head; from the latter, with which it agrees closely in ornamentation, it differs strikingly in the character of the spines, which resemble rather those of *P. comma*. It is readily distinguished from all other New England species in the contrast of colors upon the back.

Chrysalis (83:31, 33-35). Pale wood brown, streaked with greenish dusky; the tubercles are generally dusky upon one side, pale tipped; but the outer, posterior surface of the laterodorsal tubercles of the second abdominal segment are silvery or nacreous, extending in a patch to the hinder edge of the segments; similar nacreous spots occur on the first abdominal segment and on the metathorax; the abdomen is tinged considerably with dark green, which is, however, nearly or quite absent from a narrow dorsal streak and lateral triangular patches on each segment between the suprastigmatal and laterodorsal tubercles, broad at the extremity and narrow at the base of each segment; there is a broad, greenish fuscous, stigmatal streak on the fifth to eighth abdominal segments, darkest, almost black, beneath, and pale along the middle, extending, beneath, a short distance upon the fourth segment; under surface of cremaster longitudinally streaked with black and pale salmon; there are also slender, curving, subventral streaks of the latter, most distinct upon the fifth and sixth abdominal segments; each pair of legs marked at the middle and just before the tip with black. Mesonotal tubercle low, twice as long as high, well rounded in front, abrupt and angulated behind, the edge parallel to the slope of the mesonotum; ocellar prominences very long and slender, equal, with the inner angle of the tip prolonged, tapering and turned a little inward, resembling exactly the apical half of that of *progne*; as there, too, a broad U is formed by the inner edges of the ocellar prominences, but it is deeper than in that species. Extreme length, 23.5 mm.; ocellar prominences 28 mm. apart at tip; width of thorax, 6.6 mm.; height of same, including tubercle, 6.25 mm.; width of abdomen, 7.2 mm.; height of abdomen, 6.15 mm.

Distribution (19:8). This butterfly is as characteristic of the Canadian fauna as comma is of the Alleghanian, but it ranges across the continent. In the high north it has been recorded from Fort Simpson on Albany River, Rupert's House (Edwards), St. Martin's Falls (Brit. Mus.) and Moose Factory, Hudson Bay (Weir). It has also been taken at Dog's Head on the east side of Lake Winnipeg (Scudder), and at Great Slave Lake (Mus. Comp. Zool.)* Mr. Fletcher informs me since the map was printed that it is found in Newfoundland, and according to Edwards at Vancouver Island. Within the United States Edwards records it from Washington Territory, Oregon, Nebraska and Michigan, Ames finds it in Iowa, and Worthington gives it in his list of Illinois butterflies; but otherwise it has not been recorded west of the Appalachians. It occurs in abundance among the Adirondacks of New York (Lintner, Hill) and has thence undoubtedly extended to the Catskills (Edwards). But the most remarkable record is that found in a memorandum on Abbot's Georgian manuscripts in the British Museum where this butterfly unquestionably is drawn with the remark "met with by Mr. Elliot in his tour to the mountains." Edwards records one specimen taken in West Virginia by Meyer.

In New England it is a special inhabitant of the hill country and is rarely found excepting in the north, the southernmost localities from which it has been recorded being Williamstown (Scudder), Warwick (Clapp), Leverett (Sprague) and Amherst, Mass. (Marsh); Dover (Faxon), Stow (Miss Soule) and Camel's Hump, Vt. (Sprague); Dublin (Faxon) and Milford, N. H., two specimens (Whitney); and Portland "rare" (Lyman), Orono (Fernald) and Mt. Desert, Me. (Thaxter); to the east it has been taken in Nova Scotia (Jones), Newfoundland (Edwards) and on the southern shores of the Gulf of St. Lawrence (D'Urban, Bell), but it does not appear to inhabit the northern coast of the same Gulf. In the valleys of the White Mountains it is exceedingly abundant and is the butterfly oftenest seen in deep ravines and on mountain slopes below the subalpine region; more than any other species belonging to the mountain region it mounts to the very summits of the highest peaks, and both male and female are often found there far above where its larva feeds. In the valleys it affects higher levels than its congeners.

Oviposition. The eggs are laid on the upper surface of leaves, generally near the edge. Judging from specimens in confinement they lay but a few in a single day, and indeed on dissection I have never found more than two or three dozen eggs in the body of any single specimen. The duration of the egg state is one week.

* Inasmuch as Staudinger, Möschler and other European entomologists claim that this species is identical with the European *P.*

c-album, is it possible that specimens from eastern Siberia referred to the latter may really belong to the former species?

Food plants. The larva has been found on willow, *Salix humilis* Marshall, and black birch, *Betula lenta* L., belonging to neighboring families; and also upon currant (Fernald) and wild gooseberry (Caulfield, Roberts), species of *Ribes* belonging to the very distant family of Grossulaceae. Mr. Edwards wrongly quotes Caulfield as finding it upon nettle. I am inclined to believe that *Betula* is its favorite food-plant, having found it thereon upon a dozen different occasions.

Habits of the caterpillar. The caterpillar on emerging from the egg devours only its crown, and then, although as stated the egg is always laid on the upper surface of the leaf, crawls immediately to the under surface where it spends the remainder of its days. Experimented on in a closed box I found that it would keep to this surface of the leaf even when the latter was reversed to bring it uppermost, so that the different texture of the surface may have a special attraction for it, though an instinct for concealment would seem to impel its action. So far as I have seen it makes no nest of any sort in the open field, but may do so on occasion, for in one instance in confinement, when about to change to the last larval stage, it spun a feeble thread attaching three or four leaves and drew them slightly together. During its early life it has a peculiar party-colored or banded appearance produced by the alternation of dark and light papillae.

Life history. Although this butterfly flies the entire summer it is only single-brooded. It hibernates as a butterfly and appears in the early days of spring, but how early the data at hand do not enable us to say. Gosse speaks of taking it at Compton, Canada, on April 15, and Bowles says it comes out at Quebec at the end of May; visits to the White Mountains are usually not made early enough to speak positively, but it must certainly be in flight there by the middle of May and probably much earlier. In this same region it continues to fly in considerable numbers until the end of June, may still be seen occasionally as late as the middle of July, and has been taken on the 18th. The eggs are laid here during the latter half of May and the whole of June, apparently in a very deliberate manner. These hatch in a week, the larva takes about five weeks for its growth, and the chrysalis hangs from eight to fifteen days. At the White Mountains fresh butterflies appear about the middle of July before the old butterflies have disappeared. July 14 is the earliest date noted. A caterpillar, the earliest ever found, brought to the neighborhood of Boston, changed to chrysalis and gave the butterfly July 9, and in Montreal, Mr. Caulfield raised some July 3 to 6; it is generally not until toward the 20th or even later that they become common in New Hampshire, but by the end of the month they swarm. Fresh individuals continue to appear throughout the first half of August (or at least absolutely fresh specimens may then be obtained), they generally continue abundant

throughout the month, and on pleasant days may be found on the wing in gradually diminishing numbers until the middle of October. No eggs whatever are laid by these butterflies during the season in which they are born. Repeated examination of the abdomen of specimens taken at stated intervals through the season proved that the eggs are then entirely undeveloped. Before the end of October they have all hibernated, probably in hollow trees, as their haunts are woodland roads. I attempted to carry two females through the winter by enclosing them in a box (of about 160 cubic cm.) and placing it in a cold storage warehouse, where the temperature was uniformly 35° the winter through, but they did not survive the test.

Comparison with the life history of *P. c-album*. The European *c-album*, erroneously considered by some European entomologists as identical with the present species, is said by the late Meyer Dür to have two generations, the first from the last of May to early July, mainly from hibernating pupae but also from hibernating butterflies; the second from the middle of July until September; the latter brood is said to have less angulated fore wings and brighter ground colors than the spring generation; the larva is said to live on nettle, elm, currant and gooseberry.

In answer to direct enquiries, Dr. Meyer Dür wrote that he had never really obtained any hibernating pupae of the European species, but that he based his belief above mentioned on the ground "that in the early spring (March and April) not only rubbed and battered, but also quite fresh individuals are to be found." Now this does not seem to be the case with *faunus* in the White Mountains, for all specimens seen during the month of June show that they have hibernated, and the June and July caterpillars come from these hibernators. For further notes on the subject see the recent paper by Mr. W. H. Edwards (Can. ent., xix: 2-4).

In this same paper Mr. Edwards speculates on the probable genetic relationship of these two forms by supposing both species to have been derived from a common stock at the north, inhabiting both continents, but afterwards becoming separated:—

When the separation took place, the European branch split into numerous varieties, and became double-brooded, yet retained its identity as one species (that is, if the European lepidopterists of to-day are right in their views), and shows nowhere differences between any of its preparatory stages—one multiform species. And the other branch, on the western continent, threw off diverse forms, several of which have come to have very different caterpillars from the original type. These also came to be two to four-brooded, and two, at least, became seasonally dimorphic in coloration. But one form, *faunus*, remains single-brooded, and shows no tendency to vary, and may be presumed to be nearer to the primeval type of the species than any of the forms that now compose the group. Of course, this one-brooded, non-varying form is to-day not the same thing as the two-brooded, very variable form found in Europe. They have come to be two distinct species.

Habits, flight, etc. Although very quick and active in its move-

ments, this butterfly is not so shy as most species of *Polygonia*. It is readily captured, especially on the highways, where it loves to settle, with wings broadly spread, upon the ground or on twigs from three to ten feet above the ground, projecting toward the road. It is much addicted to the droppings of horses in the roads; Mr. F. H. Sprague even says that he once found them feeding on this strange food "in a state of apparent intoxication, so that I picked up many specimens in my fingers with perfect ease; three in one spot." It is seldom found far from the woods, although rarely detected within their depths but rather in sunny openings, beside mountain torrents, or in half shaded forest roads. Lintner writing of this species in the Adirondacks says: "Usually extremely shy as are all the Graptas, my approach startled only a few of their number, which after a short circuit returned to their repast. I experienced not the least difficulty in capturing twenty or more by hand."

Its ordinary flight is from three to ten feet above the ground, where it moves in a tolerably direct but slightly zigzag course, with intermittent movements of the wings; first there are three or four rapid, vigorous flaps, then it sails a few feet, then the wing beats are renewed and so on. But if alarmed it will dash about in a headlong manner, abruptly terminating its flight by pitching suddenly on a tree trunk or more commonly on a leaf of a projecting twig. At such a time it is as daring as it is impetuous, and even saucy, flaunting itself in your face and darting off again; or, if a dash is made at it with the net, it will double and throw itself after the net. Starting up a pair just at my feet one day on the Mount Washington carriage road, I stopped abruptly to see whether they would settle again. After flying a few feet away to escape the cause of their disturbance, one turned back and dashed straight at my face, turning only when within three or four inches of my nose, and then suddenly whisked off with a distinct *click* as it did so, snapping its fingers as it were in my very face.

As stated, it often rests with expanded wings flat on the ground, sunning itself; the front pair are then brought forward so as to leave between them and the hind wings a gap half way to the base; the straight antennae are raised at an angle of 45° with the vertical (about as the trunk is raised) and diverge about 85° . When at complete rest the wings are tightly closed, the fore wings brought down just sufficiently to leave no opening between them and the hind wings, and the antennae are tucked between the wings in an upright position, toward the middle of the outer margin. When at ordinary rest the wings are held erect, but parted from each other as in sunning, and the straight antennae, diverging 25° , are in direct continuation of the extreme base of the costal margin of the fore wings; the tip of the hind wings touch the ground and the body is raised a little in front. Some which had been caged, when night came, hung from the under side of twigs, the wings pendant and held as last described; the antennae were

close together, just not tucked between the wings, the clubs distant from the margin of the wings by only their own thickness.

This butterfly will feign death by lying flat upon its side upon the ground, motionless; and when in the position of ordinary repose will often give a slight trembling vibration to the wings and antennae for many minutes at a time as if suffering from cold; perhaps this latter trait is peculiar to the male.

Noting the injurious effect sudden removal to a lower level had upon some of the lifelong denizens of the upper altitudes of Mount Washington, I tried the experiment of taking three females, captured upon the summit, down to the base — a distance of level of about 3000 feet — in an hour's time. While disastrous to *O. semidea*, it had no perceptible effect whatever upon this butterfly.

Enemies. Excepting *Ichneumon versabilis* (88: 2), one of which kills a single larva and decapitates the chrysalis on its exit, no parasites are yet known to infest this insect in any stage; but to judge from my experience with rearing them in Cambridge, the young caterpillars must suffer extremely in their earliest stages from insect foes. An attempt to rear them on growing birches out of doors under nets which excluded birds, was altogether unsuccessful, and I was obliged to bring the meagre remnants of a considerable brood into the house to save them. But the butterfly itself has its foes, for in the passage already quoted from Mr. Lintner of his experience with faunus in the Adirondacks, he says that a collector had already preceded him, namely, "a large toad, whom I found holding a central position in the group and earnestly engaged in lapping up with his broad tongue one after another of the company with the greatest dexterity, seldom missing an attempt; after watching for some minutes the novel performance, I left him still gorging himself upon what I should judge to be an unusual batrachian diet."

Desiderata. In view of the reputed history of its European ally, it becomes important for those who live within the region where faunus abounds to mark the time of its appearance in the spring and autumn, and to note the sex and condition of each captured specimen, or to raise the larvae in large numbers, under conditions as nearly as possible approaching those of nature, in order to determine finally how late the chrysalids may disclose butterflies, and whether any of them continue in the chrysalis state through the winter and disclose the imago in the spring; the last condition being imperative, since the chrysalids from parasitized larvae will undoubtedly often hang until spring before the parasites make their escape. A fuller knowledge of the early stages is moreover peculiarly desirable for the sake of comparison with the European species with which this butterfly has been supposed to be identical. The place of hibernation of the butterfly is not known, and it should be noted whether the larva in its natural state ever

constructs a nest of any sort like some of its congeners. The details respecting the southern and western distribution of this butterfly are still incomplete and its parasites unknown.

LIST OF ILLUSTRATIONS.—POLYGONIA FAUNUS.

General.

- Pl. 19, fig. 8. Distribution in North America.
88: 2. *Ichneumon versabilis*, a parasite.

Egg.

- Pl. 64, fig. 21. Plain.
67: 10. Micropyle.

Caterpillar.

- Pl. 70, fig. 8. Caterpillar at birth.
74: 32. Mature.
78: 42-46. Front view of head in stages i-v.
86: 82. Dermal appendage of full grown caterpillar.

Chrysalis.

- Pl. 83: fig. 31. Outline of head, from front.
33. Side view.
34. The same in outline.
35. Front view in outline.

Imago.

- Pl. 3, fig. 2. Female, under surface.
6. Male, both surfaces.
14: 3. The same.
33: 16. Male abdominal appendages.
52: 8. Side view of head and appendages enlarged, with details of the structure of the legs.
61: 21. Outline of hind wing.
36. Cuticular processes of the food reservoir.
43. The connection of the food reservoir and stomach.
47. Side view of the digestive tract in the abdomen, to show the relative size of the food reservoir and stomach.

POLYGONIA GRACILIS.—The hoary comma.

[The hoary comma (Scudder); brown banded comma (Maynard).]

Grapta gracilis Grote-Rob., Ann. N. Y. lyc. nat. hist., viii: 432-433 (1867);—Streck., Lep., 68, pl. 8, figs. 14, 14 (1874);—French, Butt. east. U. S., 189-190 (1886);—Mayn., Butt. N. E., 14, pl. 2, fig. 15, 15a (1886).

Vanessa gracilis Kirb., Syn. catal. Lep., 182 (1871).

Nymphalis gracilis Kirb., Syn. catal. Lep., 648 (1871).

Polygonia gracilis Scudd., Syst. rev. Amer. butt., 10 (1872).

Grapta c-argenteum var. Scudd., Proc. Ess. inst., iii: 169 (1863).

Polygonia faunus var. *gracilis* Scudd., Bull. Buff. soc. nat. sc., ii: 252 (1875).

Vanessa zephyrus var. *a. gracilis* Streck., Cat. Am. macrolep., 131 (1878).

Figured by Glover, Ill. N. A. Lep., pl. 36, fig. 7; pl. 38, fig. 11, ined.

Two doves upon the selfsame branch,
Two lilies on a single stem,
Two butterflies upon one flower:—
O happy they who look on them.
Who look upon them hand in hand
Flushed in the rosy summer light;
Who look upon them hand in hand
And never give a thought to night.

CHRISTINA ROSSETTI.—*Song*.

Imago (3: 11). Head covered with mingled long, vinous, hoary and olivaceous hairs, the last predominating posteriorly, with a fringe of yellow scales at the hinder borders of the eyes mingled with many ferruginous. Sides of palpi highly variegated with a kaleidoscopic mixture of white, vino-ferruginous and black scales, the last predominating at the base, the first along the edges and in a line below the middle, the vino-ferruginous apically; the last joint ferruginous with a few black scales. Antennae black-brown above, very sparsely flecked with pale scales, naked and testaceous on the inner inferior face, outwardly heavily marked with white, which on the basal half of the antenna is mostly confined to the base of the segments, and throughout occupies more space at the base than at the apex; club black-brown above with a few inconspicuous golden hairs, black flecked with ferruginous on the outer lower side,

naked and ferrugino-testaceous on the inner lower side, the apical joints wholly naked, yellow luteous, slightly infuscated apically. Tongue light castaneous at base.

Thorax covered above with silky hairs which are dark green olivaceous changing to golden brown, beneath with mingled hoary and vino-ferruginous hairs. Fore legs with similar hairs, the front of the tibiae with a median stripe of rich, black-brown scales flanked by silvery white scales. Other femora black-brown, heavily flecked with silvery gray within and with ferruginous without; tibiae and tarsi hoary white, the former, along the middle above, and especially on basal half, marked with black-brown. Spines black; spurs and claws dark castaneous, the latter tipped with black; paronychchia dull luteous; pulvillus black-brown.

Wings above of precisely the same colors and pattern as *P. fannus* upon both wings, though in general it is slightly smaller. *Fore wings* with the upper portion of the outer border slightly concave, the dentation nearly rectangular; that at tip of lower median nervule rather prominent, strongly rounded; outer margin slightly crenulate. *Hind wings* (61:22) with the outer border considerably crenulate, the tail of the upper median longer than broad, tapering; the projection at the tip of the upper subcostal large, broad, including the middle subcostal and well rounded, that at the lower angle considerable, well rounded.

Beneath the contrasts are striking. The sexes agree in coloration. The basal half of the wings, separated from the apical portion by a line of demarcation which follows exactly the same course as in *faunus*, is of a very dark brownish ferruginous, deepening outwardly, while the outer half of the wing, excepting the markings of the outer margin, is hoary almost to whiteness, crossed especially next the mesial band by short dusky threads. The markings of the base of the *fore wings* are the same as those of *fannus*, and those of the apical half of the wing are also the same, excepting in the almost total absence of green scales from the submarginal lunules, which are here generally distinct and much smaller, never forming a common broad lunule; the interior arcuate series of green spots is supplanted by a row of inconspicuous blackish dots and the whole outer margin is unsupplied with any excepting the faintest ochreous colors, the apex being gray. On the *hind wings* the central C forms a well bent L, the longitudinal limb seldom more than half as long as the transverse, and both, but especially the lower, tapering toward their tips; while, as in the fore wings, the arcuate series of greenish spots is reduced to a row of inconspicuous black dots, and the submarginal lunules are but slightly provided with enclosed greenish lunules, though more green is to be seen than on the fore wings; ochreous colors are also wanting along the outer border, which is colored more as in *progne*, being as dark or nearly as dark as the base; the inner border is more distinctly ashen than in *faunus* outside of the series of deep loops of black threads, which ornament this part of the wing in this species.

Abdomen above with mingled black and dark orange ferruginous scales, beneath gray with mingled vino-ferruginous and hoary yellow scales, the last two joints with dark slate brown scales. Appendages of the male (33:21): upper organ precisely as in *progne*, or a trifle slighter only; clasp with the main body the same as in *progne*, but a little narrower above, the basal process of upper margin slighter than in *progne*, more depressed and more pointed; interior finger the same, but with the incurved apical portion proportionally longer.

Measurements in millimetres. Length of tongue, 9.25.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	22.	23.	24.	23.	23.5	25.
antennae.....	11.	12.	12.5	12.	11.75	12.2
hind tibiae and tarsi...	7.5	7.7	8.2	7.	7.	8.
fore tibiae and tarsi ..	4.	4.	4.1	3.5	3.25	3.75
upper median nervule of hind wings	10.	11.	10.65	10.25	10.25	11.6

Described from 16 ♂ 3 ♀.

Egg. Grass green, slightly higher than broad, well rounded, broadest in the middle

of the lower half or slightly above this, with broad base, slightly flattened summit, and nine strongly compressed, very slightly elevated, pellucid, vertical ribs which increase in height from the middle of the egg to the summit with increasing rapidity, but at the highest are only .025 mm. high. The surface between them is flat, smooth, crossed by exceedingly fine lines .02 mm. apart, which traverse and striate the ribs. The termination of the ribs at the summit leaves a free central space .25 mm. in diameter, in the centre of which the micropyle is .1 mm. in diameter. Height of egg, .85 mm.; breadth, .8 mm.

Distribution (19: 7). Excepting in New England, this butterfly has rarely been met with, but it must have a wide range through British America, for it was taken by Mr. Dall on the Yukon River, Alaska, fifty miles above Nowikákat; there is a specimen in the Cambridge Museum from Great Slave Lake, and I captured it at Dog's Head near the middle of Lake Winnipeg. Strecker also speaks of it as obtained by Geffcken in the Athabasca region, Jenner Weir records it from Moose Factory, Hudson Bay, and Fletcher found it at Nepigon north of Lake Superior, and at Sudbury north of Georgian Bay. He also tells me that it has been taken in Montreal.*

In New England it has only been reported from a few northern localities. It has been taken at Jefferson, N. H., and on the road to Wilson's Mills in Maine (Packard). It is sometimes tolerably common in the higher valleys of the White Mountains, the region where it is best known, where, however, it occupies a district distinctly lower than *P. faunus*; for instance, on the road from Fabyan's to the Base, I found *faunus* far more abundant on the portion above Twin River farm (elevation about 2500 feet) than in that below, while the reverse was true of *gracilis*. The latter flies, however, higher than this, and has even been taken on the summit of Mount Washington.

History and habits. We know very little of the history of this rare insect, the early stages being quite unknown. Efforts one spring to obtain eggs from females placed under muslin upon willow were unsuccessful although tried with several different specimens. From their times of appearance and condition, we may judge that so far as seasons and broods are concerned the history is identical with that of *faunus*, and it was this circumstance mainly that once led me to think it a dimorphic form of that abundant species. The butterflies hibernate and are to be found flying as early as anyone visits the mountains and until at least the 11th of June. They appear again in the latter half of July and fly till hibernation. The specimen taken in Alaska was found June 6; that on Lake Winnipeg August 5.

P. gracilis is less active and vigorous than *P. faunus*, is rather more shy and keeps company with its kind less; the last, perhaps, a mere consequence of its rarity. In other respects it is wholly like it, alighting like

* Butler credits it to Mendocino Co., Cal., of etiquette. See Journ. Linn. soc. Lond., zool., xvi: 467.

it in the muddy roads with erect or widely opened wings, sucking the moisture from the ruts.

Desiderata. A knowledge of the early stages and complete life history of this butterfly is much needed. Females should be confined on black birch, nettle and elm as well as willow. Do the females which are to be found in July and August ever have developed eggs in their abdomen? If they should be found, we may be confident there is a second brood, and then the comparative numbers and freshness of individuals from July on should be carefully noted.

LIST OF ILLUSTRATIONS.—*POLYGONIA GRACILIS*.

Imago.

- Pl. 3, fig. 11. Male, both surfaces.
33:21. Male abdominal appendages.
61:22. Outline of hind wing.

General.

- Pl. 19, fig. 7. Distribution in North America.

POLYGONIA PROGNE.—The gray comma.

[The gray comma (Gosse); silver-c Grapta (Kirby); Progne butterfly (Harris); Progne vaness (Emmons); spinous currant caterpillar (Le Baron); silver-l butterfly (Ross); gray-winged comma (Maynard).]

Papilio progne Cram., Pap. exot., i: 9, pl. 5, figs. E. F., (1775);—Herbst, Natursyst. ins. schmett., vii: 61, pl. 163, figs. 3-4 (1794).

Polygonia progne Hübn., Verz. schmett., 36 (1816);—Scudd., Rep. geol. N. H., i: 351-352, pl. A, fig. 12 (1874).

Vanessa progne God., Encycl. méth., ix: 292, 304, 819, 820 (1819);—Boisd.-LeC., Léop. Amér. sept., 188-189, pl. 50, figs. 5-6 (1833);—Harr., Ins. inj. veg., 3d ed., 301-302 (1862).

Grapta progne Doubl.-Hewits., Gen. diurn. Lep., i: 197 (1848);—Lintn., Proc. Entom. soc. Philad., iii: 58 (1864);—Bowles, Can. ent., iii: 10-11 (1871);—Edw., Can. ent., xii: 9-14 (1880);—Middl., Rep. ins. Ill., x: 85 (1881);—Saund., Ins. inj. fruit, 346-348, fig. 360 (1883);—Fern., Butt. Me., 55-56 (1884);—French, Butt. east. U. S., 190-192, fig. 53 (1886);—Mayn., Butt. N. E., 14-15, pl. 2, fig. 16, 16a (1886).

Vanessa (Grapta) progne Fitch, 3d Rep.

nox. ins. N. Y., 110-114 (1859);—LeBar., Rep. ins. Ill., i, 59-61 (1871).

Vanessa progne Morr., Syn. Lep. N. Amer., 56-57 (1862).

Nymphalis progne Kirb., Syn. catal. Lep., 648 (1871).

Grapta c-argenteum Gosse, Newm. Entom., 138 (1840);—Pack., Guide ins., 260, fig. 188 (1869).

Papilio progne Fabr., Mant. ins., ii: 50 (1787).

POLYGONIA PROGNE C-ARGENTEUM
The lighter form.

Vanessa Grapta c-argenteum Kirb., Faun. bor.-amer., iv: 292, pl. 3, figs. 6-7 (1837).

Polygonia progne var. *c-argenteum* Scudd., Bull. Buff. soc. nat. sc., ii: 253 (1875).

POLYGONIA PROGNE L-ARGENTEUM
The darker form.

Polygonia progne var. *l-argenteum* Scudd., Bull. Buff. soc. nat. sc., ii: 253 (1875).

... those butterflies,
Of Earth, who seek the skies,
And so come down again
(Never-contented things!)
Have brought a specimen
Upon their quivering wings.

POE.—*Fairy-land*.

Imago (3:5; 16:8). Head covered on upper surface posteriorly with olivaceous, anteriorly with mingled black, foxy and hoary hairs and with a small whitish tuft outside the base of the antennae, the sides behind the eye with mingled white, blackish and ferruginous scales. Basal half of sides of palpi white, with rather a broad median streak of black, edged above with vinous; apical half blackish mingled with vinous

or tawny, the apex of the superior fringe and the base of the inferior fringe narrowly whitish, and a median longitudinal paler streak, in continuation of the white parts of the base of the palpi; the hairs black; beneath, the white inferior fringe is seen to have a very broad median stripe of blackish and ferruginous scales. Antennae very dark brown above, lightly flecked with paler and toward the tip of the stalk with hoary scales, especially at the base of the joints; beneath, inwardly naked and pale luteous excepting near the base, where it is white outwardly with a broad patch of white on the basal half of each joint, attenuated toward the tip but toward the base of the club forming a more or less connected stripe; club dark brown above, flecked at base with whitish, beyond with ferruginous scales; beneath, fuscous, the apical three or four joints wholly pale luteous. Basal third of tongue luteous, beyond brownish fuscous, the tip luteous again.

Thorax covered above with olivaceous, beneath with dark chocolate, hoary-tipped hairs. Fore legs with a stripe of black scales down the front, bordered externally with white, internally with mingled white and fulvous scales, and fringed on either side with mingled dark vinous and hoary hairs; femora of other legs gray with an intermingling of black and white and some colored scales, at the tip yellowish, beneath with a line of black scales inwardly; tibiae and tarsi hoary white mingled with pale brown scales, the tibiae often tinged with yellowish and with a broader or narrower dark brown stripe down their front; spines blackish castaneous; spurs dark reddish, paler at base, blackish at apex. Claws dark reddish, darkest at tip; paronychial pale; pulvillus black.

Wings above fulvous orange often quite pale, almost always deeper on the basal fourth of the wings. *Fore wings* with the upper portion of the outer border slightly concave, the dentation nearly rectangular and blunter than in the other species, that at tip of lower median nervule not very prominent, broadly rounded, outer margin scarcely crenulate. The costal edge obscure, throughout marmorated with blackish and dull greenish yellow; in the middle of the cell are two small, oblique, subovate spots, the upper, more nearly transverse than longitudinal, depending from the subcostal nervure just beyond the emission of the first nervule, is directed inward; the lower, often almost circular and more nearly longitudinal than vertical, is of the same size as the upper, placed midway between it and the median nervure, its innermost extremity lying just above the base of the first median nervule; the extremity of the cell is marked by a broad, transverse, black bar, twice as broad above as below, and partially obscured by an admixture of tawny scales; it reaches from the costal margin to the median nervure, touching the latter only by its inner angle, its interior margin concave and best defined below the base of the lowest subcostal nervule; on the subcostal nervure its breadth reaches from the base of the first inferior to that of the third superior subcostal nervule; in the median and medio-submedian interspaces is a nearly straight series of three subequal, roundish, vaguely defined, blackish spots, that in the upper median interspace generally a little smaller than the others, the largest seldom more than equalling half an interspace in width, the upper one placed just before the middle of the upper median interspace, all at an equal distance from the median nervure; depending from the costal border, midway between the transverse mesial bar and the apex of the wing, is a second transverse, subtriangular, dusky patch, more or less, and nearly always considerably, tinged with ferruginous, especially externally; it is parallel to the transverse mesial bar, tapers downward and reaches the upper median nervule, its outer border passing a little beyond the last divarication of the subcostal, and has throughout vaguely defined borders, the lower portion being generally clouded and sometimes obsolescent; the outer border is very broadly margined, nearly to the depth of an interspace's width, with blackish, and above the subcostal angulation broadens as it approaches the costal border, so as to leave but a narrow space between it and the subapical, transverse blotch; this margin is directly followed in the interspaces by a series of fulvo-ochraceous lunules, not very conspicuous but often rendered more so by an interior edging of fusco-ferruginous; below the lower median nervule this expands into a large, quadrate patch, generally extending slightly above

the nervule; the outer border is sometimes faintly enlivened with scattered pale, ochraceous or tawny scales, and the fringe is blackish, broadly interrupted with the same colors, but mainly with white. Occasionally the edge of the wing has a slight hoary bloom, as in the previous species.

Hind wings (61: 23, 24) with the outer border a little crenulate, the tail of the upper median nervule either very broad at base, almost triangular (l-argenteum) or broad and gently tapering, the tip broadly rounded (c-argenteum), the projection at the tip of the upper subcostal nervule slight, angulated, that at the lower angle small and rounded. Color of the tint of the base of the fore wings, the outer border, as there, margined broadly with black, but also reaching further toward the base, and becoming more or less gradually mixed with ferruginous, until the boundary between it and the orange is marked, about midway between the first divarication of the subcostal and the outer border, by a multitude of short, transverse threads of ferruginous on an orange ground, becoming less and less frequent interiorly but seldom reaching so far as the last divarication of the median nervule; within the apical area and marking the limit of the outer edging of black, which can seldom otherwise be noted, is a series of very small, roundish, dull ochreous spots subparallel to the outer border. The basal half of the costal border, as far as the subcostal nervule, is wholly brownish fuscous, deepening into blackish at its outer limit, just below which in the upper subcostal interspace and generally crossing it is a smaller black spot, removed generally by more than its own diameter from the base of the interspace; the upper half of the nervule closing the cell is marked more or less heavily with black, which, when it is broadest, extends also over the base of the nervule above; the outer border is edged, much more frequently than on the fore wing, with a hoary bloom; fringe blackish fuscous at the nervule tips, dull ferruginous elsewhere, but occasionally interrupted with white in the middle of the interspaces and not infrequently almost wholly concealed by the hoary bloom.

Beneath gray, the basal half brownish, the apical half dull ashen, the line of demarcation on the *fore wings* being sharply defined, passing from about the tip of the costal nervule to the median nervule just beyond the tip of cell, crossing next the upper median interspace by a line subparallel to that which strikes the upper median nervule at the base of its straight portion; then crossing the lower median interspace by a similar line, whose origin on the middle median nervule is midway between the base of the nervule and the point where the line in the upper median interspace strikes it; and finally the interspaces below, still a little further removed toward the base; the darker parts of this basal field are toward the outer limits where they form an indistinct band of about the width of an interspace, while within this straight threads of pale scales, subparallel to the lower half of the outer border of the basal half of the wing, and enclosing slender stripes of slightly varying depths of brown, variegate the whole base of the wing; in particular there crosses the cell one stripe of a plumbeous color, narrowly edged with black and this again faintly with pale, extending from the base of the subcostal nervule to the median nervule just beyond the base, the homologue of the two distinct spots of the other species of *Polygonia* described in this work; on either side of it the upper half of the cell is slightly ashen; the costal edge is marmored as above but more interruptedly; excepting next the outer border the outer half of the wing is gray with short, transverse threads of blackish and fuscous, sometimes commingled to form slender streaks, upon an ashen surface more or less tinged with yellowish brown; above the lower subcostal nervule, however (excepting a narrow band next the middle of the wing), the outer half is more or less clouded with grayish ashen which extends to the outer margin of the wing; below the first superior subcostal nervule the outer border is broadly bordered to nearly the depth of an interspace's width with a color as deep as the base of the wing but more or less enlivened with pale or ochreous scales, limited interiorly by a strongly zigzag black line or series of connected sagittate spots, enclosing slender lunules of dull metallic greenish; these black sagittae are continued in the ashen tip by small, blackish dots, that of the apical subcostal interspace in the middle of its outer two-thirds; it is succeeded in-

wardly by an arcuate series of small, black dots in the interspaces, those in the upper third of the wing most distinct and largest, that in the apical subcostal interspace in the middle of its basal two-thirds and that of the upper median in its centre. Fringe much as above. *Hind wings* with similar tints to those of the fore wings, but the basal and apical halves not so distinctly separated, the whole wing covered with transverse threads of black and blackish brown, on the basal half of the wing collected to a considerable extent into slender streaks, all upon a sordid white ground, which on the basal half is tinged with dull, dingy pale greenish; the line of demarcation between the two passes from the middle of the outer four-fifths of the costal border in a sinuous course, to the middle of the basal half of the middle subcostal nervule; it starts again from a little beyond the base of the upper median nervule and passes with a tremulous course, faintly impressed, toward the base of the excision of the inner border of the wing; the apex of the cell is marked by a plain, equal or nearly equal, silver line, which does not attain the subcostal nervure and which, on reaching the median nervure at its last divarication, follows the upper median nervule to a distance nearly equal to the transverse portion, and at its tip the darker basal color of the wing terminates; occasionally the longitudinal limb is nearly obsolete and it usually tapers apically; it is usually twice as broad as the nervules at this part of the wing; the outer margin of the wing is scarcely darker than the surrounding parts, though usually a little infuscated, but there is a submarginal, sinuous, slender, black stripe, at the distance of nearly an interspaces' width from the outer border, which is almost entirely filled up with dull greenish scales; a short distance within this is a very obscure transverse series of black dots in the interspaces, almost wholly obliterated by being made the centre of a transverse, partially connected series of blackish streaks, hardly as far from the submarginal stripe as that from the outer border. Fringe much as above.

Abdomen blackish brown above covered rather profusely with tawny scales; beneath ashy grey with mingled pale, light brown and pale tawny scales. The opening at the extremity in the male is constricted, transverse, rounded, strongly arched above, nearly straight below, half as broad again as high. The upper organ of the male appendages (33:13) has the hook as in *P. faunus* but more strongly arcuate, as long as the body, without basal tooth. Clasps nearly three times as broad as long, the upper hinder angle only slightly produced and rounded, slightly incurved; basal process of upper surface twice as long as the clasp and slender, the apical half directed backward, equal and scarcely depressed; at the middle bent abruptly inward and downward in a slightly sinuous curve, depressed, tapering regularly to a pointed tip; interior finger long and slender, tapering slightly throughout but more conspicuously toward the base, arcuate, on the apical third finely pointed and scarcely surpassing the upper edge of the clasp.

POLYGONIA PROGNE C-ARGENTEUM.

Measurements in millimetres. Length of tongue, 9.5.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	23.5	25.25	26.25	23.75	25.5	26.5
antennae.....	12.5	13.5	14.25	12.	13.	13.2
hind tibiae and tarsi.....	7.85	8.5	9.	7.4	8.2	8.5
fore tibiae and tarsi.....	4.4	4.6	4.9	4.	4.5	4.

POLYGONIA PROGNE L-ARGENTEUM.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length fore wing.....	24.	26.	27.5	23.5	27.5	27.5
antennae.....	12.	13.75	14.5		13.5	
hind tibiae and tarsi.....	7.5	8.5	8.4	7.1	8.25	8.6
fore tibiae and tarsi.....	4.2	4.4	4.4	3.7	4.	4.4

Described from 27⁺specimens, of which 9 ♂ 11 ♀.

Dimorphic forms. P. P. C-ARGENTEUM. Has the ground tint of the upper surface of all the wings concolorous.

P. P. L-ARGENTEUM. Has the base of the hind wings obscured above with dusky tints. It differs from the preceding, so far as the markings are concerned, but very little and, as there, the sexes do not differ; the fore wings are identical on both surfaces; the upper surface of the hind wings is more heavily infuscated on the outer half, reaching further toward the base, but never concealing the distinctness of the black spots of the middle of the wings; the submarginal series of fulvous spots are almost wholly though never fully obliterated; on the under surface, the L-shaped mark at the tip of the cell is as a rule slenderer than in c-argenteum, being of about the width of the nervules in this part of the wing, although individuals of the former occasionally have it as indistinct as here, and the longitudinal limb is always much shorter than the other, by which it approaches more the exact form of an L or is sometimes wholly obliterated.

Egg (64 : 25). Laminate ribs ten in number, commencing below at the rounded under surface and continuing of nearly the same height over the lower half of the egg, leaving a free space on the summit, .2 mm. in diameter; the ribs are .02 mm. in thickness and on the sides are .025 mm. high, while on the summit their elevation increases to .07 mm.; surface smooth, glistening, broken into cells by straight, exceedingly delicate, scarcely raised cross lines, .02 mm. apart, visible on the ribs only on the upper part of the egg. Color pale greenish, the ribs pellucid. Height including the ribs, .95 mm.; breadth, .81 mm.

Edwards describes the egg as having eight or nine ribs; all that I counted had ten.

Caterpillar. *First stage.* Head shining piceous, hairs and ocelli black; the mouth parts, in part at least, pale. Body grass green, the segments very pale green anteriorly, tinged with reddish brown posteriorly; warts and hairs black; spiracles blackish fuscous; legs blackish fuscous; prolegs greenish yellow tipped with fuscous. Length, 3 mm.

Second stage. Head (78 : 47) very dark castaneous with blackish hairs arising from the tubercles. Body dark olivaceous green, the mammiform bases of the spines and the last four or five segments marked with dull, dirty, yellowish orange; the oblique streaks of the adult are barely discernable. Spines blackish brown, the spinules emitted mostly near the summit; the latter terminate with long, nearly straight, blackish hairs, and the main spine is surmounted by a longer hair; on the second and third thoracic segments a minute, subdorsal wart gives rise to an erect blackish hair. Spiracles fuscous. Legs greenish yellow at base, beyond fuscous; prolegs greenish yellow, fuscous at tip. Length, 6 mm.

Third stage. Head (78 : 48) blackish, marked to a greater or less extent with spots and blotches of obscure reddish orange; the spiniform tubercles are blackish or reddish at base, white at tip, surmounted by a black hair; ocelli orange in a black area; mouth parts mostly black. Body purplish fuscous, with two narrow, transverse, dull lemon yellow bands at the posterior border of the segments; the mammiform elevations bearing the spines are dull reddish orange, connected with the anterior border of the segments by short patches of the same color; spines usually dark purplish black, sometimes luteous; the subsidiary spinules generally blackish but sometimes luteous. Spiracles black, broadly annulated with luteous, which is itself sometimes narrowly bordered without with whitish. Legs black, obscure luteous at base; prolegs rufoluteous, brownish at base, and with a purplish spot at the tip exteriorly. Length, 15 mm.; breadth, 3 mm.

Fourth stage. Head reddish brown obscured by blackish, the suture of the triangle dull orange, the spiniform tubercles orange or whitish, emitting a pale hair, the larger one in the middle of each hemisphere black; summit spine usually black, but occasionally in part, orange; the hairs all black; basal joint of antennae reddish, the apical black; mouth parts reddish brown. Body marked with black and pale yellow; a slender, pale, dorsal line extends over a part of the thoracic segments; behind the spines, each segment of the body is black, with three narrow, transverse bands of pale

yellow; in front of the spines is a small black spot and separated from it and from each other by rather broader, pale orange bands, are two still wider inclined stripes or bars; a narrow black band unites the laterodorsal spines of the thoracic segments; the last segment is blackish; there is a very narrow, pale orange, infrastigmatal line; the body beneath is blackish, marked with yellowish, the latter predominating on the seventh and eighth abdominal segments. The short spines of the first thoracic segment are orange colored; spines of dorsal series pale, seated on orange tubercles, their spinules pale, excepting those of the eighth abdominal segment which are black, and the spiny bristles are black; those of the laterodorsal series black on the thoracic, pale on the abdominal segments, the spinules of the spines of the thoracic segments being black when their insertion is high, orange at base, and black beyond when it is not: the spinules and hairs of the abdominal spines is as in the dorsal series. Spines of the laterostigmatal series like the laterodorsal thoracic spines, but the spinules more extensively orange; the abdominal black, their spinules orange at the base. The spines of the infrastigmatal series are orange or pale with orange or pale spinules, bearing fuscous bristles. The longest spines are those of the laterodorsal series on the thoracic and eighth abdominal segments. The tubercles upon which the spines are seated bear also everywhere minute, pale, yellowish papillae, giving rise each to a short delicate hair. Spiracles black. Legs black, the claws reddish brown; prolegs dark reddish brown, covered with orange papillae bearing short hairs. Length, before the growth of this stage is fully attained, 17.5 mm.; breadth of body, 3 mm.; length of longest spines, 2.5 mm.

Fifth stage (74: 31). Head (78: 49) brownish fuscous, occasionally tinged with ferruginous, the sutures marked with ferruginous; lower part of the triangle and the sides of the head between the ocelli and labrum, dark greenish vinous. Spiniform tubercles whitish or yellowish, the largest, in the middle of each hemisphere, blackish tipped with yellow, all emitting short, luteous or brownish yellow hairs. Summit spines black and some of their spinules whitish. The coronal spine is long and slender, the lateral spinules emitted near the centre, and although also long and slender, not so long as the apical half of the main spine; above them the main stem sometimes emits occasional short, fine, horizontal hairs from minute raised points. First joint of antennae pale, third blackish, the bristle pale; ocelli black; labrum dark greenish vinous; mandibles blackish.

Body yellowish brown, changing, especially on the sides of the abdominal segments, to dull salmon, and marked with blackish olivaceous; a slender, pale, dorsal line on the thoracic segments; first thoracic segment blackish and blackish fuscous; upper surface of the body crossed next the sutures by three or four narrow, alternating, transverse stripes of black and yellowish brown; the abdominal segments, and especially those provided with prolegs, have a small, triangular, blackish olivaceous spot in front of the dorsal spine; an oblique subdorsal stripe, which is sometimes united to its mate by curving around behind the dorsal spine; broad, curving, lateral and stigmatal stripes, each of which passes between the spines; and an irregular, infrastigmatal, yellowish line. The spines (86: 68) are furnished high up with five spinules, forming a sort of wreath, each spinule placed at an angle of about 60° with the apical portion of the main stem; there are seldom more than one or two spinules of any magnitude on the lower portion, and the latter is destitute of pile; they are mostly black with whitish spinules and dark rufous bristles, but the dorsal ones of the first to seventh abdominal segments and the laterodorsal ones of the second to sixth abdominal segments are altogether whitish excepting the bristles; and those of the infrastigmatal row are whitish excepting at the base. The short spines of the first segment are white and orange, bearing rufous hairs. The body is covered infrequently with very delicate, short, nearly invisible, brownish hairs, seated on minute, whitish papillae arranged in transverse rows. Spiracles shining black, narrowly annulated with pale slate color. Legs black, tinged with rufous; prolegs blackish olivaceous, black at tip, the anal pair beset with white papillae giving rise to rufous hairs. Length, 27.5 mm.; breadth of body, 4.25 mm.; breadth of head, 2.75 mm.; length of spine on summit of head, 2 mm.; length of spine on second thoracic segment, 3.15 mm.

On the variation in the larva see Edwards, Can. ent., xii: 12-13.

Chrysalis (83: 32, 37, 38). Head and front white tinted with pale olivaceous, vermiculate with salmon creases; the basal joint of the antennae and the ocellar prominences, excepting beneath, dusky olivaceous, often marked with brown or blackish fuscous. Ocellar prominences not very long, with the basal half scarcely tapering, at the middle with a slight notch, leaving outside a very small tubercle, separated from the apical half which is conical and curved a little inward, the inner margin of the whole prominence forming with its mate a broad U with curving sides; middle joints of legs heavily, and base of tongue slightly, tinted with dark olivaceous; the basal half of the antennae more or less marked with pale olivaceous. Wings salmon buff on an obscure whitish ground, or gleaming silvery white with a nacreous tint; they are more or less suffused or tinged in broad streaks with pale olivaceous, especially near the tip and across the middle on the anterior slopes of the elevations; exposed surface of under wings, next the first abdominal segment, fuscous. Thorax salmon buff like the wings and streaked as there; or pale salmon white longitudinally, and obliquely streaked with pale, delicate green, the edge of the dorsal prominence sometimes black; first four abdominal segments pale or buff-salmon, sometimes irregularly discolored with greenish brown; the metathorax and first two abdominal segments with pretty large, laterodorsal, nacreous spots; the first abdominal segment with a similar dorsal spot; laterodorsal tubercles of fourth abdominal segment scarcely larger than the others; behind the fourth segment the abdomen is of a duller or dirtier salmon color; the abdomen is marked with a pale salmon colored dorsal streak, bordered with greenish, or with subdorsal triangular patches of olivaceous which are more distinct at their posterior extremities; fifth and succeeding segments with a distinct, broad, dark olivaceous, stigmatal stripe, sometimes blotched with black, narrowing posteriorly and serrate above; followed beneath by a very broad, pale, substigmatal band, streaked obliquely with greenish along the middle; there is also a broad, ventral, pale greenish band, fainter posteriorly; the suprastigmatal warts are black; all the tubercles are salmon colored, greenish or pale with black tips, excepting sometimes the last subdorsal pair; there are a few short, transverse, fuscous punctures on the first to fourth abdominal segments. Spiracles black, narrowly and faintly edged with whitish. Cremaster above whitish, longitudinally streaked with fuscous; beneath blackish fuscous, the rim pale, sides blackish. Length, 22 to 23.25 mm.; ocellar prominences, 2 mm. apart at tip; width of head at base of ocellar prominences, 3.5 mm.; width of thorax, 6.9 mm.; of abdomen, 7.5 mm.; height of thorax, 6.1 mm.; of abdomen, 6.75 mm.

Distribution (19: 6). The range of this butterfly corresponds very closely with the upper half of that of *P. interrogationis*, but the limits are slightly removed to the northward; although most properly considered a member of the Alleghanian fauna, it is not found in abundance toward the extreme southern limits of that district, while on the north it more frequently and considerably invades the region of the Canadian fauna. Mr. Uhler considers it rare in Maryland, but Mr. Edwards states that it is common at Elk River, West Virginia, though it is not found near by at Coalburgh, Kanawha Co.; these are apparently its southernmost stations, for it has not been reported in other southern localities where *P. comma* seems to be abundant; the original habitat given by Cramer ("Jamaica") is unquestionably erroneous, as well as the enumeration of this butterfly among the Cuban species by Lucas in Sagra's Cuba. In the north it occurs at Quebec (Bowles), Montreal (Caulfield), Ottawa (Billings), Sault, Lake Superior (Bethune), the Lake of the Woods and Dufferin

(Dawson), Fort McLeod, Belly River (Geddes), Cumberland House on the Saskatchewan (Kirby) and, if we are really to credit the reference, on the Arctic coast, west of the mouth of Mackenzie River (White, in Richardson's Journey). Eversmann even gives it a place in his Lepidoptera of eastern Siberia, stating that it is found in Viloui. So also it figures in Staudinger's Catalogue from Kamschatka; but probably an allied species has been mistaken for it, perhaps *P. zephyrus* Edw. Saunders says it is found north of our territory "to the Pacific," but I find no warrant for it. In the west it has been taken in United States territory in Wisconsin (Hoy), Iowa (Osborn, Parker, Putnam), Fort Niobrara, Neb. (Carpenter) and the Big Horn Mountains, Wyo. (Edwards). This and Fort McLeod are its westernmost known stations. Reakirt quotes Edwards only in referring it to Colorado, but the species concerned was afterwards described as distinct. In the east it has been found in Nova Scotia where it is rather common (Jones), at several localities on the lower St. Lawrence (Bell), at Godbout River on the north shore of the same (Corneau) and at Anticosti (Couper).

In New England it is more generally distributed and universally common than any other species of *Polygonia*. It is somewhat more abundant in the southern than the northern parts, but has been taken as far as Mount Desert Island (Scudder), Orono (Fernald), Hallowell "very scarce" (Miss Wadsworth) and Norway, Me. "common in some seasons" (Smith); Thornton and Shelburne, N. H. (Faxon) and Stow, Vt. (Miss Soule). In the White Mountains it is occasionally common, but is rarely seen above 2,000 feet, above which it is replaced by *P. faunus*. Thus I found it only on the lower half of the wagon road from Fabyan's to the base of Mount Washington. It will probably be found to be comparatively rare in the elevated regions of northern New Hampshire and Maine.

Oviposition. The eggs are laid singly on the upper surfaces only of leaves, with little selection of the exact spot, excepting that they are frequently at the very edge; one sent by Mr. Angus was laid at the extreme tip, as in the genus *Basilarchia*. The duration of this stage is four or five days.

Food plants. The food of this insect in the larval stage consists of currant, wild gooseberry (*Ribes rotundifolium* Michx.) and rarely elm (*Ulmus americana* Linn.). It has also eaten in confinement the cultivated blackberry, and will doubtless live equally well on any of the Grossulaceae, wild or cultivated. Dr. Le Baron states (1st Rep. nox. ins. Ill., 60) that it has done considerable mischief among the currant bushes in Kankakee Co., Ill., by stripping off their leaves, and Mr. Saunders reported in 1884 (Can. ent., xvi:181) that in one locality in West Ontario fear was entertained for the currant crop; but as he says elsewhere it "rarely appears in sufficient numbers to prove troublesome." Van Duzee suggests

that from the resemblance of the caterpillar on well shaded leaves to a yellow, partially dead leaf of gooseberry, it may "derive perhaps some protection."

Habits of the caterpillar. The caterpillar eats only the summit or at most the upper quarter of the egg on escaping from it, leaving the main walls untouched; when feeding it eats the edge of the leaf in rather deep gashes, not avoiding the midrib, and detaching its terminal legs from the leaf curves the last two segments upward; it eats but sparingly and grows with corresponding slowness; it is ordinarily very quiet and feigns death when disturbed, but at times its movements are very rapid and uneasy.

The caterpillars live entirely exposed without making any form of nest, relying for concealment only on their home on the under side of leaves. "In the later stages they have a very odd habit of holding themselves when at rest: the anterior segments arched and turned round at a right angle to the rest of the body, the middle segments bent in, and the last three segments often thrown high in air, as in certain species of heterocerous larvae; the larva then rests wholly on the abdominal legs. I have seen nothing like this in any other *Grapta* larva" (Edwards).

For specimens of this stage of the insect I am indebted to Messrs. Clapp, Saunders and Sprague, and to Miss Guild.

Change to chrysalis. The transformation of the gray comma "appears to consist of two stages: the first is slow, gradual and almost imperceptible, occupying some twenty-four hours of time, during which, it may be presumed, there is effected a gradual separation of the larval from the pupal envelope. During this period the caterpillar hangs with its body curved forwards and upwards, and appears to be almost motionless; but upon close observation it is seen to undergo almost continuous though slight changes, consisting of a nodding motion of the head, and an occasional variation in the curvature of the body. The second stage is short and active, usually lasting but a few minutes, the object of which is to throw off the loosened larval skin; first, by bending the body it bursts open the skin upon the back, and then, by a wriggling motion, works it up towards the point of attachment, and lastly detaches and throws it entirely off by a series of violent contortions, apparently at the imminent risk of severing the thread upon which its safety literally depends" (Le Baron).

Life history. The species is double brooded, and like its congeners, the butterfly hibernates and is one of the first to feel the approach of spring, reappearing on sunny days at the end or even by the middle of March. Toward the close of April and early in May it flies in considerable numbers and continues upon the wing until early in June, occasionally to the middle. The eggs are laid, apparently, about the middle of May and the larvae transform to chrysalids from about the middle of June to the early part of July—at least in the vicinity of Boston; this state

continues from ten to sixteen days*, according to the observations of Harris, Gosse, Fitch, Packard, Lintner, Sprague and Edwards. The earliest butterflies from these chrysalids generally appear in the first days of July, sometimes as soon as the 24th of June; they are, however, seldom abundant before the second week in July and continue to be seen until about the 10th of August, or in northern New England later than this. The eggs of this brood of butterflies are laid in July, generally in the latter half, and in northern New England up to the middle of August, and, hatching in four or five days, the larvae change to chrysalids from about the middle of August until early in September; this stage lasts as long as in the first brood, and the butterflies appear again generally about the 22d or 23d, sometimes as early as the 18th of August, become abundant by the first of September, and continue to emerge from the chrysalis at least until the 8th of September. They may be found in much greater abundance than the first brood all through September, but by the middle of October nearly all of them have sought their winter quarters beneath a tree-limb or in some sheltered crevice. Mr. Lintner intimates that the chrysalis may also occasionally hibernate and disclose the butterfly early in the spring; I have never taken fresh specimens in the spring, but the suggestion is worth careful investigation.

Habits and flight. Though much less active than *P. faunus*, this wary and agile insect is rather difficult to secure. It is often seen sipping the sweet juice of drying or decaying fruit. It frequents lanes and openings through light woods and even dusty highways; at the least alarm it darts into the thicket, returning soon, however, to reconnoitre and, if the enemy is still in view, settling only at a safe distance. It is in the habit also, along woodland roads, of "alighting in the dust to enjoy the hot sunshine or may be seen sipping moisture from muddy spots. . . . When alighted they usually keep perfectly quiet and if disturbed the wings are spread widely open, at which time the insect is quite conspicuous; but when slightly alarmed, the wings are closed and then, on account of the gray color which harmonizes perfectly with the surroundings, the butterflies are quite difficult to detect" (Maynard). According to the observations of Dr. Webber, it is fond also of pitching on apple trees, opening its wings to catch the full rays of the sun.

In hibernation the wings are placed back to back, the fore pair separated from the hinder ones, the internal margin of the fore wing being visible as far toward the base as the inner limit of the broad pale band beyond the middle of its under surface; the antennae are hidden between the fore wings and held perpendicular to the plane of the body.

Gosse relates (*Can. nat.*, 259) that he has observed on nearly every one of these butterflies which he took in Canada little soft club-shaped

* Dr. Le Baron had specimens (of this brood?) disclose in seven days, at a time when the thermometer remained at about 100 deg. (Rep. nox. ins. Ill., i: 60.)

filaments, bags of pollen of *Asclepias* flowers, about one-sixth of an inch long, projecting from the head, generally from the eyes. Similar objects were seen by him in Alabama on the heads of swallow-tails. It shows the part taken by these butterflies in the fertilization of flowers.

Parasites. Mr. Couper states on information received from Mr. Caulfield that the larva of this species is subject to the attack of a "small parasite" like a *Pteromalus*, which issues from the chrysalis. The egg, too, is subject to the assault of a tiny enemy, *Telenomus graptæ* (89:9), which I have obtained in place of the caterpillar I desired.

Desiderata. Several points in the history of this insect require special investigation. The larva is said by Harris to feed on elm, but no one else appears to have found it thereon. Was this a mistake? Does the chrysalis ever hibernate and how late in the spring may the hibernating butterflies be found? Within what limits of time are the eggs of the first brood laid? What is the exact time when the summer brood of butterflies appears, increases and vanishes? How does its flight compare with that of other species of the genus and what other parasites has it than those known?

LIST OF ILLUSTRATIONS.—*POLYGONIA PROGNE.*

- | <i>General.</i> | <i>Chrysalis.</i> |
|---|---|
| Pl. 19, fig. 6. Distribution in North America. | Pl. 83, fig. 32. Outline of head from in front, enlarged. |
| 86:9. <i>Telenomus graptæ</i> , a parasite. | 37:38. Side views. |
| <i>Egg.</i> | <i>Imago.</i> |
| Pl. 64, fig. 25. Plain. | Pl. 3, fig. 5. Male, both surfaces. |
| <i>Caterpillar.</i> | 16:8. Both surfaces. |
| Pl. 74, fig. 31. Colored, mature. | 33:13. Male abdominal appendages. |
| 78:47-49. Front views of head in stages ii, iii, v. | 61:23. Outline of hind wing of <i>P. p. l-argenteum</i> . |
| 86:68. Dermal appendage of last stage. | 24. The same of <i>P. p. c-argenteum</i> . |

EUGONIA HÜBNER.

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| <i>Eugonia</i> Hübn., Verz. bek. Schmett., 36 (1816). | <i>Vanessa</i> (pars) Auct. |
| <i>Nymphalis</i> Scudd., Syst. Rev. Amer. Butt. 10 (1872). | <i>Type</i> .— <i>Pap. polychloros</i> Linn. |

The downy orchard, and the melting pulp
Of mellow fruit, the nameless nations feed
Of evanescent insects.

THOMSON.—*Summer.*

Imago (53:6). Head pretty large, pretty densely clothed with longer and shorter hairs. Front very moderately and pretty uniformly swollen, being scarcely fuller beneath, broader than high, scarcely so broad as the eyes; upper edge rather sharply rounded, protuberant in the middle between the antennae and terminating abruptly; lower edge rather broadly rounded. Vertex rather small, slightly tumid, in no part rising beyond the upper level of the eyes, very broadly rounded behind. Eyes large, pretty full, pilose with short hairs. Antennae inserted in the middle of the summit in pretty deep, nearly connected pits, their interior bases separated by a space nearly equal to twice the width of the antennal stalk, their exterior close to the margin of the eye;

half as long again as the abdomen, composed of forty-four joints, the last twelve of which form a very oblong-ovate cylindrical club, a little depressed, about twice as broad as the stalk, more than five times as long as broad, the extremity very bluntly conical, the last three or four joints entering into the diminution of size and successively turned a little outward, so that the outer edge of the club is nearly straight to the tip, and the inner broadly rounded; furnished beneath with a very slight triple carina, scarcely visible on any portion of the stalk. Palpi stout, about two and a half times longer than the eye, compressed, scarcely curved forward above, the terminal joint about a third the length of the middle, the whole heavily clothed throughout with somewhat erect scales and furnished with a few moderately long, slender hairs both above and below, all directed in a vertical plane.

Prothoracic lobes large, tumid, especially behind, the ends well rounded, scarcely smaller outwardly, a little appressed in front, fully three times as broad as long and as broad as high. Patagia twice as long as broad, very broad, well rounded and nearly circular at base, scarcely at all swollen, the posterior lobe very slender and tapering, projecting backward as a slightly falcate blade, the tip roundly pointed.

Fore wings (38:8) considerably more than half as long again as broad, the costal border scarcely bent at a little distance from the base, beyond that nearly straight to an equal distance from the tip, where it becomes more curved; outer border with the portion above the middle of the lower subcostal interspace very slightly concave, having a general direction at a very little less than a right angle with the central portion of the costal border, beyond receding suddenly at a little more than a right angle to the middle of the subcosto-median interspace and continuing in a deep, crenulate curve to just below the lower median nervure, where a prominent rounded tooth is formed and below which the border is excised, the angle rounded off; inner border very nearly straight, scarcely convex on the basal two-thirds. First superior subcostal nervule emitted a little beyond the middle of the outer two-thirds of the upper margin of the cell; the second a little more than half way from the origin of the first to the tip of the cell; the third midway between the tip of the cell and the origin of the fourth; the latter at three-fifths the distance from the tip of the cell to the apex of the wing; second inferior subcostal nervule arising scarcely one-third way down the cell; the latter considerably less than half as long as the wing and three times as long as broad. Middle of the basal curve of the last median nervule connected with the vein closing the cell.

Hind wings slightly and broadly convex, less so away from the base; the outer angle very broadly rounded off by the gradual slope of the outer border, which is well rounded, crenulate, slightly and very broadly prominent in the subcostal region, produced at the tip of the upper median into a rather broad, well rounded tail, a little longer than broad, scarcely tapering, below which, excepting the crenulations, the border is nearly straight; the inner border is considerably expanded near the base, beyond a little convex, broadly and roundly excised in its apical third, the outer angle a right angle, but well rounded. Precostal nervure originating considerably beyond the divarication of the costal and subcostal nervures, minutely forked at the tip, the longer fork directed outward; cell closed by a very feeble vein.

Fore legs small, cylindrical, scarcely depressed, thickly clothed with a bushy, depressed bunch of long, somewhat spreading hairs, thicker and more widely spread in the male than in the female; tibia three-fifths the length of the hind tibia; tarsi about three-fifths the length of the tibia, either consisting of three indistinct joints, the first a little longer than the others together, these two about equal, all unarmed (σ) or, distinctly composed of five joints, of which the first is three times as long as all the others together, these growing successively smaller toward the tip, all armed beneath with a pair of very small and short apical spines, the field in which all but the basal pair occur being bare of scales (φ). Middle tibiae scarcely so long as the hind pair, furnished on either side beneath and on the upper portion of the inner side with a row of not very frequent, pretty long and moderately slender, slightly spreading spines, the terminal ones of the inferior rows developed into short, moderately stout spurs. First

joint of tarsi equalling the rest together, the three following diminishing regularly in size, the fifth of the length of the second; joints furnished beneath with four, the terminal joint with only two, rows of moderately long and slender spines, the apical ones of each joint slightly longer than the others. Claws small, rather delicate, curving pretty strongly, tapering to a pretty sharp point; paronychial bifid, the outer blade slender, as long as the claws, curving considerably and tapering to a very delicate point; the inner scarcely more than half as long, very delicate and slender and tapering to a minute point, curving slightly inward, but otherwise nearly straight; pulvillus wanting; terminal tarsal joint with four apical, very long, curved, thread-like spines, directed between the claws.

Abdominal appendages of the male: upper organ closely resembling that of *Polygonia*, its inferior arms projecting a little backward below the anus. Clasps very similar to those of *Polygonia*, differing only in that the upper basal process is larger, entirely above the upper edge of the clasp, and although somewhat similarly curved, extended upward; it is supplied at the interior base with a ridge, which meets another falling from the upper edge of the clasp to form a support or socket for the tip of the interior finger, which does not reach the upper edge of the clasp.

Egg. Barrel shaped, with rather tumid sides, not very much taller than broad, broadest in the middle of the basal half, furnished with seven or eight compressed laminate vertical ribs, which start from near but not quite at the base, or at least only become distinct above the base, constantly increase in height, but even at the summit are scarcely so high as in the preceding and following genera; the interspaces are crossed by very numerous and crowded, distinct, raised cross lines forming cells a dozen or more times broader than high. They are laid in a single compact mass, one layer deep, encircling a twig.

Mature caterpillar. Head rather small, subquadrate on a front view, the sides regularly and broadly rounded, broadest in the middle, the summit slightly depressed in the middle and produced at the anterior outer portion; head not greatly deeper below than above, a little broader than high; the triangle half as high again as broad, reaching more than half way toward the summit; summit bearing on each side either a very stout, long spine, directed upward and considerably forward and outward, encircled near the middle by a stellate arrangement of four or five spreading, greatly upturned, stout, slightly tapering spinules, bluntly rounded at the tip like the main spine, and emitting a long, bristly hair; or a collection of simple, tapering, rather short and bluntly pointed tubercles. The head is also beset with very many elongated, stout, cylindrical but tapering, spinous, bluntly tipped tubercles, emitting a rather long, delicate hair, some of which, especially upon the hinder edge, are very long and large, while others are small, almost minute. Antennae as in *Polygonia*, with the last joint slightly longer. Ocelli six in number, five arranged in a moderately strong curve, whose convexity is forward; the upper four are at nearly equal and slight distances apart, the upper a little further from the second than the others among themselves, the fifth at a still greater distance, and the sixth bearing the same relation to the others as in *Polygonia*; the second to fifth are more prominent than the others. Labrum well rounded, almost the entire outer portion excised almost to the base by a triangular cutting, the sides of which are less than a right angle. Mandibles not very large, broad and stout, their edge straight and entire. Maxillary palpi four-jointed, each succeeding joint smaller, the first and second half as long as broad, the third half as long again as broad, the last very small, conical. Spinneret rather long and very slender, equal.

Body having the form of that of *Polygonia*, with longitudinal markings most conspicuous in the dorsal region and next the stigmatal line (at least in the European species), armed with numerous spines arranged in longitudinal rows, one to a segment in each row as follows: a dorsal series, placed anteriorly on the first to the eighth abdominal segments; a laterodorsal series, scarcely in advance of the centre of the same; a supralateral series similarly placed on the second and third thoracic segments, all of these sometimes, but not always, markedly longer than the rest; a latero-stigmatal series, similarly placed on all the abdominal segments; a stigmatal series centrally

placed on the second and third thoracic segments; and an infrastigmatal series placed centrally on the first to the eighth abdominal segments. The spines are very long and stout, not quite straight, but bending slightly toward each principal spinule. Each spine with from three to seven spinules of nearly equal length, and about one-fourth the length of the spine, rather slender and tapering, armed at tip, like the spine, with a rather short, tapering, thorny bristle, the spinules emitted with great irregularity in the middle two-fifths of the spine; the spines are also covered with infrequent miniature spinules, each emitting a rather long, delicate hair. Spiracles obovate, twice as long as broad. Legs rather long and not stout, tapering gently.

Chrysalis. Resembles *Polygonia* in almost every particular; the anterior half of the under surface is slightly curved longitudinally; on a side view the ocellar tubercles are rather slender, the lower surface being placed at a slight angle with the portion behind, and the upper surface also forming a slight angle with the dorsum of the pro- and mesothorax, instead of being continuous with it as in *Polygonia*. Dorsal projection of the mesonotum not compressed so strongly as in *Polygonia*, not very large, moderately high, nearly as high as long, highest posteriorly, the anterior border curved but little and irregularly, the posterior border straight and perpendicular or slightly inclined; the supralateral tubercles of the mesonotum and metanotum are more prominent than in *Polygonia*, being higher than broad and the former without any inferior ridge. Anal hooklets like those of *Polygonia*, but rather more strongly curved.

This genus includes five known species, comprising butterflies generally above the average size, three belonging to the Old and two to the New World. They are all peculiar to the north temperate zone and nearly or quite girdle the earth. Two of the species, *vau-album* and *xanthomelas* (the former closely allied to our single New England form and by some authors considered identical with it), are confined to central and eastern Europe; a third, *polychloros*, is spread over nearly the whole of Europe and all of the northern half of Asia; a fourth, *californica*, occurs on the western coast of America in California and Oregon; and the last, *j-album*, is found along the boundary between the United States and Canada from the Rocky Mountains to the Atlantic; and also throughout New England.

A fossil butterfly, *Eugonia atava*, found in the tertiary beds of Rado-boj in Croatia, appears from the description and illustration given by Heer to belong also to this genus and to resemble most closely that section which includes our New England species.

The butterflies strongly resemble those of the preceding genus in the form, color and design of the wings, but on the upper surface of the fore wings the costal markings are much heavier; the hind wings are bordered nearly or quite as distinctly as the fore wings, and all their darker markings are confined to the costal and subcostal areas; the central comma-like mark beneath is reduced to a faint, short, bent line often nearly obsolete.

The butterflies are single or double brooded and pass the winter in the imago state; *polychloros*, according to Mr. Stainton, hurries to its winter quarters as soon as it escapes from its chrysalis in the autumn; it then appears early in the spring as if fresh from the pupa, and has therefore been supposed by some (Meyer Dür, Prittwitz, etc.) to winter both as a chrysalis and as an imago; whether the other European butterflies of this

genus have a similar habit is not stated, but the butterflies of our New England species are among the last to disappear, so far as one can judge from simple dates of capture. The earliest butterflies from chrysalids of the same year appear about the middle of July, and a second irruption or a new brood about the first of September.

The eggs are laid in clusters around a twig as in *Euvanessa* and not as in *Polygonia*, and naturally, as in the former genus, the larvae feed in company, mostly upon *Ulmaceae* and *Salicaceae*. *E. californica*, however, is said to feed on *Ceanothus thyrsiflorus*, one of the *Rhamnaceae*. The caterpillars have the head ordinarily surmounted by a pair of stout, long spines supplied with a whorl of spinules near the middle like those of the preceding genus, and the body provided with spines closely resembling those of the caterpillars of *Polygonia* but longer. The chrysalis resembles that of *Polygonia* in almost every particular, but with a less compressed, dorsal, thoracic prominence and more prominent tubercles on the thorax. These butterflies have generally been placed with *Euvanessa* and *Aglais*, but, as will be seen, by the preceding, they are more nearly related to *Polygonia*.

*EXCURSUS X.—BUTTERFLIES AT NIGHT AND AT SEA;
OUT OF SEASON AND OUT OF PLACE.*

Far out at sea—the sun was high,
While veered the wind and flapped the sail:
We saw a snow-white butterfly
Dancing before the fitful gale
Far out at sea.

The little wanderer, who had lost
His way, of danger nothing knew;
Settled awhile upon the mast:
Then fluttered o'er the waters blue
Far out at sea.

Above, there gleamed the boundless sky:
Beneath, the boundless ocean shewn:
Between them danced the butterfly.
The spirit-life of this vast scene.
Far out at sea.

The tiny soul that soared away,
Seeking the clouds on fragile wings,
Lured by the brighter, purer ray
Which hope's ecstatic morning brings—
Far out at sea.

Away he sped, with shimmering glee,
Scarce seen, now lost, yet onward borne!
Night comes with wind and rain, and he
No more will dance before the morn,
Far out at sea.

He dies, unlike his mates, I ween,
Perhaps not sooner or worse crossed;
And he hath felt and known and seen
A larger life and hope, though lost
Far out at sea.

R. H. HORNE.—*Genius*.

BUTTERFLIES are creatures of the land and of the day. No aquatic form is known, or one that is aquatic in any stage of its existence. They love the sun and warmth, being essentially tropical animals, every one of the larger groups decreasing in representatives in passing from the tropics towards the poles. They rarely undergo their transformations other than above the ground, and mostly in midsummer. They fly by day and generally by brightest day and in clearest weather. Yet there are some groups which love the forest gloom, and a few which, in tropical countries, favor the twilight. There are a few, too, which venture to make their homes in the frigid zones, and on high and bleak mountain summits.

There are, however, exceptions to nearly every general rule, and a few of them may be related here.

About fifteen years ago, I was spending the summer on the island of Nantucket. The under keeper of the powerful flash light at Sankaty Head brought me one day a tin box full of "moths" which had been fluttering around his lantern in great swarms the night previous. On opening it, I discovered a dozen living specimens of *Eugonia j-album*. Hundreds of them had flown into the lantern the preceding night, and had given him a great deal of trouble. This is the first instance, so far as I can learn, in which butterflies have been known to fly by night, and it was the more surprising because this butterfly had never before and has never since been found by me upon the island of Nantucket. Nor do I think there are enough plants there upon which its caterpillars would be likely to feed to support any considerable brood. Since then, Miss Murtfeldt of Missouri has stated (*Psyche* iv: 206) that after ten o'clock one August evening a specimen of *Doxocopa celtis* entered the open window of her sitting room attracted by the light and was captured in a butterfly net. Another specimen was taken earlier in the evening but after the lamps were lighted. A hackberry tree, *Celtis*, on which the larva feeds, was near the window. An instance still more nearly approaching the first is stated to have been mentioned at a meeting of the Brooklyn Entomological Society in October, 1885; Dr. C. Hart Merriam was quoted as having mentioned that a light-house keeper on Lake Ontario had been greatly annoyed by the large swarms of *Anosia plexippus* that flew against it and obscured the light. These are the only instances that I have been able to find, either in this country or elsewhere, of the attraction of butterflies to ordinary light; but since the introduction of electric lights into our cities, entomologists have made use of them for the capture of insects, many nocturnal animals being attracted from all the surrounding country by the brilliancy of the light, and among them, according to Mr. Henry Edwards and others, several species of butterflies (*Ent. amer.*, i: 160). Most of them, like the preceding, were members of the highest family, *Nymphalidae*, viz., *Anosia plexippus*, *Vanessa atalanta*, *V. cardui*, *V. huntera*, and *Euvanessa antiopa*; and, besides these, *Cyaniris pseudargiolus* and *Euphœades troilus*. As all these instances, excepting that mentioned by Miss Murtfeldt, were cases of exceptional brilliancy and magnitude in the light, it is hardly to be presumed that we shall change our opinion that butterflies, as a rule, are insects of the day, although, as is well known, there are certain groups, especially of the *Satyrinae*, which in the tropics are accustomed to fly by twilight and even in the rain.

My attention was early called to the occurrence of butterflies far out at sea by seeing, on my first natural history expedition over thirty years ago, a specimen of *Euvanessa antiopa*, which visited our vessel on the 26th of

February, while off the coast of North Carolina and some twenty or thirty miles from land, making us a short and flighty visit. One of the most remarkable instances, however, is that related by Darwin in his "Naturalist's voyage around the world," p. 158: "One evening," he says, "when we were about ten miles from the Bay of San Blas [northern Patagonia], vast numbers of butterflies, in bands or flocks of countless myriads, extended as far as the eye could range. Even by the aid of a telescope it was not possible to see a space free from butterflies. The seamen cried out 'It was snowing butterflies,' and such in fact was the appearance. More species than one were present, but the main part belonged to a kind very similar to, but not identical with, the common English *Colias edusa*. Some moths and Hymenoptera accompanied the butterflies; and a fine beetle (*Calosoma*) flew on board. . . . The day had been fine and calm, and the one previous to it equally so, with light and variable airs. Hence we cannot suppose that the insects were blown off the land, but we must conclude that they voluntarily took flight."

Observers in India and other tropical regions have noticed on many occasions vast swarms of Pierinae moving in a line along the sea coast, and occasionally such swarms have been seen in similar situations in temperate regions; thus Dr. Schulte (*Ent. nachr.*, iii: 71) relates that in a dead calm off Nordeney in the Baltic Sea, he steamed for three hours and a distance of thirty miles through a continuous flock of *Pieris rapae* from ten to thirty miles from the main land and only five miles less than that from the nearest island; afterward the shore was found strewn with their dead bodies. And on our own side of the ocean we have a curious instance related of *Eurema lisa* by Mr. J. M. Jones, who states that early one October morning several persons living on the northern side of the main island of Bermuda perceived what they thought to be a cloud coming from the northwest, which turned out to be "an immense concourse of small yellow butterflies, which flitted about all the open grassy patches and cultivated grounds in a lazy manner, as if fatigued after their long voyage over the deep," and fishermen out that morning stated that their boats were literally covered with these butterflies. Other instances are recorded by Caldcleugh and Cornelius. I have elsewhere recorded the tendency of *Anosia plexippus* to swarm along the water edge as if preparing for a great flight, and also the fact that this butterfly must have flown vast distances over the Pacific Ocean to have tenanted the scattered islands where it is now found. Also that it was seen by one naturalist in the south Pacific five hundred miles from the nearest island, and on the Atlantic ocean "hundreds of miles from land." There is also a single record of the occurrence of *Pieris rapae* on one of the transatlantic steamers, when more than a thousand miles from land (*Psyche* i: 152). This last might perhaps be accounted for on the supposition that the insect had emerged from a chrysalis on

board, which had matured during the passage. But a still more striking instance of the occurrence of Lepidoptera far out at sea, on account of the number of species concerned, is given in a recent number of Science (ix: 340), where Mr. Lucas records that while in latitude 25° south and a thousand miles from the nearest portion of the coast of Brazil his party “encountered several light squalls of wind and rain, during one of which two butterflies were driven past. The weather continued squally all night and for part of the next day, the wind coming from the westward. The following morning it was found that quite a number of Lepidoptera had been blown on board, and ensconced themselves in various places sheltered from the wind. They were mostly, if not wholly, nocturnal species of small size, although one large hawk-moth was among them. About twelve or fifteen specimens representing nearly as many species, were captured, and others seen; so that not less than twenty or thirty individuals must have reached our ship.” This number of specimens at so great a distance is certainly very remarkable and shows that the occurrence of butterflies at sea must not be looked upon as excessively rare, and explains without doubt one means by which the natural distribution of butterflies from one region to another may take place.

*** For fuller details, see papers quoted under *Anosia plexippus* and *Eurema lisa*; and Müller's paper on the dispersal of non-migratory insects by atmospheric agencies, London, 1871 (Trans. ent. soc.).

EUGONIA J-ALBUM.—The Compton tortoise.

[The Compton tortoise (Gosse); The white-j butterfly (Harris); comma butterfly (Emmons); many colored vaness (Emmons); the j-butterfly (Ross).]

Vanessa j-album Boisd.-LeC., Lép. Amér. sept., 185-186, pl. 50, figs. 1, 2 (1833); Morr., Syn. Lep. N. Amer., 56 (1862);—Harr., Ins. ing. veg., 3d ed., 298 (1862).

Grapta j-album Lintn., Proc. Entom. soc. Philad., iii: 58-59 (1864);—Fern., Butt. Me., 56-57 (1884);—French, Butt. east. U. S., 192-193 (1886);—Mayn., Butt. N. E., 15-16, pl. 2, fig. 17, 17a (1886).

Nymphalis j-album Scudd., Syst. rev. Amer. butt., 11 (1872).

Vanessa urticae Harr., Hitchc. rep., 590 (1833).

Vanessa polychloros? Emm., Agric. N. Y., v: 208 (1854).

Vanessa vau-album (pars) Kirb., Syn. catal. Lep., 184 (1871).

Nymphalis vau-album (pars) Kirb., Syn. catal. Lep., 648 (1871).

Vanessa pocahontas Harr., MS.

Figured by Glover, Ill. N. A. Lep., pl. 37, fig. 2, ined.

[Not Pap. urticae Linn., nor Pap. polychloros Linn., nor Pap. vau-album Wien. verz.]

A few pale flowers of summer late
For languid butterflies, wind-tost, that leave
Their garden asters, tempted to their fate
By the wild bees.

TODHUNTER.—In September.

Imago (3: 9). Head covered above with a mass of long, mingled ferruginous, pale and blackish hairs, the paler ones predominating; sides and beneath with pale brown scales, behind the upper part of the eye mingled profusely with tawny and dusky ones; palpi dull whitish, with a slight tuft of black scales at the base on either side, a slender

row of the same along the middle of the under surface, one or two scattered black scales along the sides, and all the long hairs below and at the sides black, excepting on the apical joint, where they are partly rufous; the apical joint and the upper surface of the middle joint pale, dingy rufous, the superior fringe of middle joint pale, blackish at base, causing a blackish, slightly oblique stripe from the upper edge of the middle of the joint to, or nearly to, its apex; antennae blackish above, faintly and irregularly enlivened with rufous, beneath naked and then castaneous, the basal half of each joint on its outer inferior surface heavily flecked with whitish; club blackish above, dusky beneath, the white flecking dying out on some of the basal joints, the apical three or four joints wholly luteous; tongue luteous at base, with blackish edges, beyond black, paler interiorly, the tip bright luteous.

Thorax covered above with olivaceous and tawny hairs, beneath with pale yellowish brown ones; fore legs deep black down the middle of the front, fringed with pale brownish yellow; the other legs clayey brown, the femora marked above and narrowly beneath with purplish black, their tips slightly tawny, the tarsi, especially of the hind pair, slightly dusky above; spines reddish luteous, the spurs the same, but black tipped; claws reddish, their apical third darker; paronychiae blackish.

Fore wings above at base for scarcely more than one-fourth way to the apex, dark tawny, more or less infuscated; the costal edge mottled with blackish and yellowish white; crossing the cell is a broad, irregular black bar, the outer upper corner of which is at the origin of the first subcostal branch, and which just fails of reaching the median nervure; it is generally rudely angular or protuberant in the middle of its exterior border, and is nearly twice as broad, from nervure to nervure, as long; beyond this is a large black patch depending from the costal border and reaching the median nervure; its interior limit follows the outer limit of the cell; its exterior forms an irregularly sinuous curve, which passes usually just within the origin of the third superior subcostal nervure; the patch is half as long again above as below; beyond this is another black patch of similar size and form, but with less sharply defined borders, depending from the costal margin, reaching scarcely past the lowest subcostal nervure, its interior border separated at the costal margin from the preceding patch by the same distance as that is from the spot in the cell, and receding a little from it as it passes downward; it tapers rapidly in its posterior half, is rounded beneath, and followed next its upper half by a small, transverse, diagonal, white stripe, broken by dusky nervules; beyond this to the marginal band the wing is blackish in the upper subcostal area; between these two black patches the wing is of a more or less deep orange tawny, paler or yellowish in the upper third or more; these two tints occupy all of the wing beyond the base not covered by black patches; a large, reniform, black patch, with ill-defined borders, occurs just below the second divarication of the median nervure, and crosses both the lower median and the medio-submedian interspaces diagonally, in a direction at right angles to the costal border; in the median interspaces, at a similar distance from the outer border, their outer edges next the middle of the middle median nervure, are two large, deep, subquadrate, black lunules, scarcely reaching the median nervules, which are edged with deeper tawny than the rest of the wing; the extreme base of the upper median interspace is more or less infuscated; in the medio-submedian interspace, midway between the large reniform spot and the outer border, is a large, transverse, ovate blotch of the same color crossing the whole interspace, lying parallel to the lowest extremity of the outer margin, and, with the spots in the median interspaces and the costal patch in the middle of the outer half of the wing, forming a rude, interrupted, transverse, sinuous band, whose outer limits are subparallel to the outer border, and which is followed in the lower two subcostal interspaces, and all those below it excepting next the inner border, by orange tawny, more or less begrimed with brownish, and enclosing in the middle of the interspaces faint, ill-defined, longitudinally ovate, pale patches; outer margin to the depth of half an interspace dusky brown, occasionally enlivened with greenish yellow or tawny, and almost always paler in the interspaces, and especially in those of the median area; this is deepened interiorly into dark ferruginous brown, sometimes mingled with blackish and

ruddy, and followed by a paler streak, varying from whitish to yellowish tawny or greenish, which again is separated from the paler spots by a slender, transverse, blackish brown band, broadest in the median area, except next the costal margin, where it reaches the white spot; fringe black, interrupted rather narrowly in the interspaces, and especially those of the median area, with whitish. *Hind wings* orange tawny, more or less begrimed with dusky, profusely clothed with long, fine, tawny hairs (tinged with olivaceous nearest the base of the wing) in the lower inner part of the wing; the limit of it would be marked by a line following the upper border of the cell and sweeping around to just before the tip of the inner border; excepting some paler clouds on the costal margin, the upper basal half of the wing, including the base of the lower and the basal third of the upper subcostal interspace, is blackish brown, followed above the middle subcostal nervule by a white bar, nearly an interspace in width, in the upper subcostal interspace, removed a little toward the base, tapering upwards, and ill-defined in the interspace above; this is again followed by a dusky triangular patch tapering downward from the costal margin, where it is flecked with paler colors to a rudely formed apex at the middle subcostal nervule; connected with the exterior border of this patch is a submarginal, connected, slightly crenulate series of ferrugineo-blackish transverse bars, opening outward, at a distance of about three-fourths of an interspace from the outer margin, angulated like the wing, but to a less degree, at the upper median nervule, and followed interiorly by a series of high, greenish yellow lunules, more or less connected, especially in the middle of the wing, into a series which tapers toward either extremity, and does not pass beyond the subcostal nervules; the tawny portion of the wing next to them is also more or less broken by lighter fleckings of the same color; the outer margin is also of this color, but is more or less obscured with dusky or flecked with mingled tawny and blackish scales, frequently in transverse threads; fringe mingled yellowish and dark brown, interrupted narrowly with white in the interspaces.

Beneath, in general dark brown on the basal half of the wings, darker in ♂ than in ♀, the apical half, excepting a submarginal stripe, hoary cinereous (♂) or dusty cinereous (♀); whole surface, excepting the apical third of fore wings, profusely covered with exceedingly delicate, blackish, aculeate, recumbent hairs. In the *fore wings* the limit of the darker basal half runs from the costal margin just opposite the base of the third superior subcostal nervule, turns directly toward the base so that it crosses the subcostal nervure as far within the base of the third nervule as that is from the costal margin, and then runs straight, but often in a crenulate course, to the upper median nervule or just below it, just where it completes its basal curve; from here it continues in a slight curve, opening outward, to the middle of the basal fourth-fifths of the inner border; this exterior limit of the darker base is sometimes marked by a blackish line, especially in the upper subcostal and upper median interspaces; it also marks the outer limit of the darker part of the base, which forms a broad, nearly equal band, broadest above, reaching the upper outer limit of the cell, and there only distinctly defined, being marked like the upper portion of the exterior limit by a black line, followed by gray markings; within this band, which is least defined, narrowest and lightest in the subcosto-median interspace, there is an oblique black streak in the upper subcostal interspace, joining above the exterior margin; within the cell are three small, darker, clouded patches—one slender, oblique, black bordered, with rounded extremities, seated on the median nervure a little less than half way from the base to its first branch, directed parallel to the subcostal nervure and almost reaching the second spot, which is similar, not quite so slender, bordered with black, excepting at the inferior part of its basal extremity, its upper outer extremity touching the base of the first subcostal nervule, its lower directed between the first and third spots; the latter subrhomboidal, similar and parallel to the second, but broader and not or scarcely bordered with black, is seated on the median, its outer edge next the first divarication of the nervule; the base of the medio-submedian interspace is also clouded, limited by the continuation of the outer margin of the outer spot in the cell. The whole costal edge is marmorate with blackish and whitish. Below the next

to the lower subeostal nervule there is a submarginal black stripe, parallel to and distant by the width of an interspace from the outer margin, enclosing next its exterior limit an equal stripe of dark dull bluish, half as wide as the black stripe in which it occurs; between this and the dark basal half of the wing it is mottled and blurred in the ♂ with black, white, pale brown, pale yellowish brown and ferruginous scales, forming a freckled, ashy gray band, more or less ochrey in the apical half, with paler patches next the costal margin opposite the lighter parts above, and with darker clouds in the interspaces down the middle; in the ♀ it is nearly uniformly dull, dirty gray brown, paler in the costal patches and next the darker base; in both, the interior half, below the middle median nervule, is traversed by frequent, short, transverse, nearly straight, black or dusky threads, and there is a transverse, sinuous series of blackish dots subparallel to the outer border in all the interspaces that open on the outer border above the lower median nervule; that in the upper median interspace occurs in its centre; the outer margin of the wing is darker again, especially between the next to the lower subeostal and the lower median nervules, where it is usually marked by a darker stripe lying midway between the edge and the submarginal stripe. Fringe as above, or not so dark. *Hind wings* having the darker basal half limited, across the whole or nearly the whole wing, by a slender black stripe, which starts at about the middle of the outer two-thirds of the costal margin and runs to the middle of the basal two-thirds of the upper subeostal nervule, just before which it is bent outwards; it then curves outwards in a series of bent lines to the lower subeostal nervule at a short distance beyond the base; a second similar curve carries it to the middle of the basal two-thirds of the lower median interspace; here it starts again on a similar curve, but passes as far only as the lower median nervule, then starts again from beyond the middle of this nervule and passes in a series of deep loops opening inward to the base of the excision of the inner margin; lost for a short distance, a continuation of the line is seen passing, when most complete, in a series of large and deep loops, toward the base of the wing parallel to the inner border, crossing the internal nervule two or three times; the base of the wing is traversed abundantly by transverse, short, blackish threads, and by one more distinct nearly straight stripe, passing from the costal margin at right angles, and striking the subeostal at its first divarication; two darker clouds, faintly edged with black, cross the cell, one at the tip and a broader, slightly angular one in the middle; there is also a small roundish spot at the extreme base; a slender, angulated, white line follows the lower half of the vein closing the cell and the upper edge of the upper median vein beyond it, the longitudinal limit of the L thus formed being sometimes twice as long as the transverse; sometimes it is wholly or partially obsolete; distant from the outer margin by the width of an interspace is a series of nearly or quite connected bluish crescents, edged on either side with black, generally more heavily in the middle of the wing on the interior side; and between these and the mesial black line the wing is colored much as in the apical half of the fore wings, excepting that it is more or less clouded with olivaceous ochrey in the middle of the outer half of the band, and within which the arcuate series of black dots is found above the lower median nervule, that in the upper median interspace scarcely beyond its centre; the wing is margined as the middle of the fore wing and fringed as on the upper surface of the hind wing.

Abdomen above black, more or less flecked, especially on sides and at the apex of the segments, with tawny fulvous, beneath dark brown toward the base, gradually merging into the dull yellowish brown which marks the apex of the segments and the whole of the terminal joints. Male appendages (33:17, 18): upper organ; hook almost straight, a little tumid on basal third, beyond equal, depressed at base, and bearing beneath a prominent tooth. Clasps nearly four times as broad as long, diagonally fabiform, the upper hinder angle slightly but broadly produced and incurved a little; upper basal process nearly as long as the breadth of the clasp, tapering throughout but less so on the basal three-fifths than beyond; basal portion compressed, thickened along the upper edge, directed backward and somewhat upward and slightly curved inward, beyond curved strongly inward and slightly downward, the apex ex-

tended delicately and sinuously to a fine point; interior finger long and slender, tapering gently throughout, straight, excepting as it follows the curve of the clasp.

Measurements in millimetres. Length of tongue 12.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	32.5	33.5	36.		33.5	
antennae.....	15.5	16.75	17.5		16.25	
hind tibiae and tarsi..	10.	10.5	11.			
fore tibiae and tarsi..	5.8	5.8	6.2		5.1	

Described from 12♂ 1♀.

Caterpillar. *Last stage.* Head light colored, the triangular suture dusky, the bottom of the triangle fuscous, and all the sides, from the interior base of the summit spine to the anterior portion of the ocellar field, and excepting a curved streak running backwards above the ocellar field, blackish; summit spine entirely black, very stout, the spinules emitted about the middle, the basal portion half as long again as broad, the spinules very stout, scarcely tapering, abruptly docked, not so long as the apical portion, and diverging from it at an angle of about 30° to 40°, the main stem provided with a few miniature spinules emitting rather long hairs; other spiniform papillae pale, the hairs also pale; mandibles very dark reddish.

Body "light green, the dorsal and subdorsal rows of spines shining black, except at base, which is rufous, with long branches; those of the anterior segments more numerous branched than the others and having each point tipped with a seta; the super and substigmatal rows rufous, tipped with black. Length two inches" (Lintner).

Chrysalis (83:36, 44, 45) of a "beautiful green, delicately reticulated," the mesothoracic and first and second abdominal tubercles of the laterodorsal series "golden" exteriorly and posteriorly; mesonotal tubercle similar to that of *P. comma* and ridged "with black anteriorly . . . stigmata brown with a brown spot beneath"; cremaster "bordered with brown" (Lintner). Length 25.5 mm.; height at mesonotal tubercle 9 mm. By Mr. Lintner's favor I have seen the skin of his original specimen.

Distribution (20:4). This butterfly, more properly a member of the Canadian than of the Alleghanian fauna, occupies nevertheless nearly the whole northern half of the latter, being reported from Iowa (Austin, Osborn), northern Illinois "abundant" (Thomas), Wisconsin (Chamberlin, Hoy), southern Michigan "common" (Harrington), New Harmony, Ind.,* (Boisduval-LeConte), Rockport, Poland and Cleveland, Ohio (Kirtland, Kirkpatrick), Fredonia, N. Y. (Mark), Philadelphia "rare" (Blake), Maryland "rare" (Uhler) and Long Island (Graef). A single individual of what was probably this species ("polychloros") is reported by Jones as taken in Bermuda by Canon Tristram†. In the north this species is generally very common throughout all the inhabited part of Canada. It has even been found within the limits of the Arctic fauna, at Okak in Labrador, whence it was brought by Dr. Packard, and specimens

*This seems doubtful; for it may simply have been received from Say.

†It is also quoted in Sagra's Cuba among the butterflies of that island, but so many other butterflies foreign to Cuba are catalogued in the same work, that its testimony is of little value; yet there is a single worn specimen of this species in the Museum of Comparative Zoology, purporting to have been taken in

Cuba by Mr. Charles Wright; this botanist has certainly collected largely in the mountains of Cuba, but Dr. Gundlach has for years devoted particular attention to the insects of this island, collecting in every part of it without meeting this butterfly. It seems, therefore, more probable that there has been some error in the labelling of this specimen in the Cambridge Museum.

labelled "Arctic America, Ross" may be seen in the British Museum, probably collected in the vicinity of Great Slave Lake. The localities already specified indicate all that is known of its western extension, excepting that Mr. Edwards found one specimen in a collection from Lake Labache, British Columbia, Captain Geddes records it from Kicking Horse Lake in the Rocky Mountains, Lord from Vancouver's Island (under the name of polychloros), and Fletcher has received specimens from Cariboo, British Columbia, collected by Cowley. Eastward it reaches to Godbout River, Gaspé and Nova Scotia, and will probably be found in Newfoundland, though Gosse did not find it there.

It occurs throughout New England, although very rare in the southernmost portions; yet it has been taken in Newport, R. I. (Higginson) and Nantucket (Scudder), and was one single year reported very common in Springfield, Mass., though very rare since (Emery). It is also reported from Farmington and New Haven, Conn. It has been taken occasionally in several localities about Boston, while in the White Mountain district and its vicinity it is abundant, as it doubtless is through all that portion of New England lying north of the isotherm of 40° for the spring months.

Periodicity. This is another of the butterflies of which we see vastly more in one year than in another. Harris noticed this as long ago as 1827, as appears from his note books, but it is never very common in the southern half of New England, where most of our entomologists live, and no years can be specified. Bowles says (Can. ent., xii: 136) "they were so abundant one summer that I even saw them drinking spruce beer from the old apple-woman's kegs in the Upper Town Market, Quebec, while next season the only specimen I found was a poor, dilapidated individual which I took snugly tucked away under the coping of a fence, where it had evidently passed the winter."

Haunts. Like the *Polygonias* "it seems to have a predilection for ripe or decaying fruit, and often visits our cider mills when apples are collected in large numbers" (Kirtland). At other times it may be seen in company with the *Polygonias* and resembles them in its flight; it affects high, open woodland and hilly roadsides; it is also wont to pitch on the trunk of a tree, with its head downward and its wings tightly shut back to back; in such a position it is with difficulty discovered, even by one who has seen it alight, so closely do the gray tints of the under surface correspond to the color of the bark upon which it rests.

Food plant of caterpillar. The only specimen of larva known was full fed and crawling when captured, so that the food plant is not certainly known. But Mr. Caulfield informs me that Mr. P. Knetzing says it is the white birch (*Betula alba* var. *populifolia*). It has commonly been supposed that it was willow, and poplar has also been suggested. It has been taken at willow blossoms.

Life history. The data at hand regarding this insect and our ignorance of the larval history do not permit us to speak with confidence regarding its seasons, nor be sure whether in the southern part of its range it is single or double brooded. In the White Mountain region, where I have most frequently seen it, it is certainly single brooded, and I am inclined to think that the same is true of it further south. It hibernates as a butterfly (and occasionally as a chrysalis?). The butterfly is one of the earliest to leave its winter quarters, specimens being seen occasionally by the middle of March,* becoming abundant by the end of the first week in April and flying until early in June. Mating takes place early in the spring, but the eggs can hardly be laid before the leaves are fairly out, and the only information we have of the subsequent changes before the advent of the butterfly is that a caterpillar at Schoharie, N. Y., found by Mr. Lintner, changed to chrysalis on June 27 and emerged in thirteen days. All observers agree that this spring flight is much less extensive than the numbers which appear in the autumn, but exceptions are known when a change occurs from a year of plenty to the reverse; the spring flight, the relics of the abundant harvest of the previous year are then found to be commoner than their next descendants. The first brood of the year makes its appearance about the 10th of July or a very little earlier (rather later at the White Mountains) and becomes more and more abundant as the season progresses. Specimens of the female examined at the White Mountains in the latter half of July and all through August showed that the eggs were completely undeveloped, so that the larger numbers one finds there the latter part of August are not due to the advent of a new brood, but to the fact that they continue to emerge from the chrysalis from their first appearance in July until the end of August, the cause of which it is hard to divine, since it is highly probable that the eggs are laid in masses, and within a period the range of which is very limited, certainly not above three weeks. Whether further south, where the time for development is longer, the butterflies of the July brood lay eggs or not, is uncertain; it is only clear that though the first butterflies appear early in July, they are far more numerous late in August and September and continue on the wing through October and sometimes even into November. These butterflies hibernate, selecting old buildings for their refuge and appearing to have a desire for higher culture. Rev. Mr. Fyles discovered them in an unused room in the upper story of the Missisquoi High School in Canada. Professor S. I. Smith once found two specimens in a school house in Norway, Me., in December or January, which, on being placed in a warm spot in the sun, revived and flew about the room. Mr. Lintner has

*Since this was written Mr. F. H. Sprague writes me: "It may interest you to know that I saw a specimen of j-album in pretty good condition and quite lively flying by my

window this afternoon (Feb. 12, 1888). The temperature was at 33 deg. at the time and there were six inches of snow that had fallen the previous night."

suggested that some of the second brood of chrysalids may continue in that stage throughout the winter, although he has since had reason for doubt. The late appearance of many butterflies certainly renders it likely, although it still remains to be established.

Habits, flight, etc. "This insect is one that is most difficult to catch. It rests with closed wings, and the dull hues of the exposed under sides closely resemble those of the fencing on which the insect usually settles. As an intruder upon its haunts approaches it, it dashes away with a speed that sets pursuit at defiance" (Fyles). It is to be found along the roadsides in the White Mountains in peaceful company with *Polygonia faunus*, sucking the juices from the droppings of horses and cattle. It is rather more wary than its smaller companion, but resembles it closely in its actions.

In sucking, or at rest on a horizontal surface, the wings are tightly closed and erect, the front wings well forward, the antennae spread nearly at right angles; but alighting in the sun the wings are sometimes spread to their full extent. Resting in cloudy weather on the ground, the wings are held erect and tightly closed as before, the palpi nearly and the antennae quite vertical, the latter diverging only 20° from each other; the thorax has an angle of about 140° with the abdomen. The same general attitude in reverse is assumed when hanging from a horizontal surface.

When settled for the night on a vertical surface, it rests with the head downward, the wings tightly shut, the costal edge of the front pair at right angles to the body, the antennae tucked together next the front wings, attingent, the outer half scarcely projecting beyond the costa. Some that were hanging thus on the window frame of my room were evidently disturbed by the tremor occasioned by a cart passing on the road fifty feet distant.

Butterflies are not generally known to fly by night, but a curious instance happened a dozen years ago when on a cloudy and unusually warm night in September, butterflies of this species flew into the lantern of Sankaty Head Light, Nantucket, a powerful flash light, in such numbers as to give the keepers much trouble by obstructing the flow of oil in the lamp. One of the keepers brought me a dozen of them alive, saying that hundreds had flown into the lantern and there were many more outside. Yet in a five years summer residence and collecting there I had never seen the butterfly. Is it possible that the species regularly migrates and by night? Attention should here be called to Mr. Thaxter's observations (Can. ent., xii: 38) that he has seen "clusters of *Vanessa j-album* on tree trunks at dusk in New Hampshire."

Desiderata. Where so little is known of the history of a species, a list of desiderata seems superfluous, for notes of every sort are desirable; yet it is worth while to invite enquiry into the effect that butterflies from wintering chrysalids would have upon the time of appearance of the first

brood of larvae; also to ask why it is that the butterflies are so much less abundant in the spring and in midsummer than in the autumn as to have entirely escaped the notice of many collectors; to direct attention to the question of the number of broods in southern New England, and finally to request observers to note how soon after eclosion the autumn generation seeks its winter quarters; all facts regarding swarms of this species are worth publication.

LIST OF ILLUSTRATIONS.—*EUGONIA J-ALBUM*.

<i>General.</i>		<i>Imago.</i>	
Pl. 20, fig. 4.	Distribution in North America.	Pl. 3, fig. 9.	Male, both surfaces.
	<i>Chrysalis.</i>	33: 17.	Male abdominal appendages.
Pl. 33, fig. 36.	Outline of the mesothoracic tubercle.	18.	Inside view of same.
44.	Side view.	38: 8.	Neuration.
45.	Ventral view in outline.	53: 6.	Side view of head and appendages enlarged, with details of the structure of the legs.

EUVANESSA SCUDDER.

Papilio Linn., Syst. nat., ed. x., i: 458 (1758); Scudder *Grote*, Can. ent., v: 144 (Aug. 1873).
 Scudd., Syst. rev. Amer. butt., 11-16 (1872); [Not Scudder *Stål* (April 1873).]
 Proc. Amer. acad. sc., x: 238-240 (1875). *Type*.—*Papilio antiopa* Linn.

This, this! is beauty; cast, I pray, your eyes
 On this my glory! see the grace! the size!

These brilliant hues are all distinct and clean.

CRABBE.

I cannot tell what the dickens his name is.

SHAKESPEARE.—*Merry Wives of Windsor*.

Imago (53:4). Head pretty large, densely clothed with a bushy mass of long and short hairs. Front well rounded, tumid, protuberant beneath, broader than high, of just the breadth of the eyes; upper edge bluntly rounded and protuberant in the middle, falling rather abruptly into the transverse pit of the antennae; lower edge broadly rounded, almost docked. Vertex moderate, very tumid, projecting very considerably and throughout its whole length above the level of the eyes, very broadly rounded behind, in front projecting with curved sides deeply and rather sharply into the space between the antennae, where it is deeply sunken and connected with the front by a narrow bridge. Eyes pretty large, full, sparsely pilose with pretty nearly uniform long hairs. Antennae inserted very slightly indeed in advance of the middle of the summit in deep, nearly connected pits, their interior bases separated by a space equal to the width of the antennal stalk, and their exterior closely crowded upon the margin of the eyes; they are about half as long again as the abdomen, consisting of 44 or 45 joints, the last eleven or twelve of which form a very oblong, ovate, cylindrical club, about two and a half times as broad as the stalk, four and a half times as long as broad, the extremity very bluntly conical, the last three or four joints entering into the diminution of size, and successively turned a little more outward, so that the outer edge of the club is nearly straight to the tip, while the inner is broadly rounded; terminal joint minute, furnished along the under portion of the inner side with a delicate triple carina, continuing indistinctly over a portion of the stalk. Palpi moderately stout, fully three times as long as the eye, compressed, curved outward above, the terminal joint two and a half times shorter than the penultimate, the whole furnished sparsely above and beneath with very long, bristly hairs, directed in a vertical plane and heavily clothed with somewhat erect scales.

Prothoracic lobes pretty large, not very tumid, anteriorly appressed, broadly rounded posteriorly, tapering a little exteriorly, but scarcely at all interiorly, four times as broad as long, considerably higher than long. Patagia scarcely twice as long as broad, gently tumid, very broad and nearly square at base, the outer border straight, the inner rather deeply concave, so that the posterior lobe narrows rapidly at first and then tapers gradually to a rounded point, the posterior portion being, as it were, triangular with the outer hinder angle greatly produced; the interior border is roundly, rather broadly ridged.

Fore wings (38:15) a very little more than half as long again as broad, the costal margin considerably bent at a short distance from the base, beyond, nearly to the apex, almost straight, very slightly convex, the apical part curved somewhat backward; the outer border is a very little crenulate, its upper portion, as far as the middle of the lower subcostal interspace, slightly concave, having a general direction at right angles to the middle of the costal margin; below this, to the middle of the succeeding interspace, suddenly receding and then passing in a nearly straight course, broken by the crenulations, and by a little, broad, rounded projection, just below the lower median nervule, to the well rounded lower angle: inner margin very nearly straight. First superior branch of the subcostal nervure emitted in the middle of the outer half of the upper margin of the cell: second, half way from the origin of the first to the tip of the cell—both a little further from the base in the male than in the female: origin of the third midway between the tip of the cell and the base of the fourth, the latter arising at more than three-fifths the distance from the tip of the cell to the apex of the wing: second inferior branch arising scarcely more than one-quarter way down the cell; the latter two-fifths as long as the wing and about three times as long as broad: the distance from the origin of the second median nervule to the vein closing the cell is half that to the base of the first median nervule.

Hind wings with the costal margin somewhat bowed, rather more strongly on the basal than on the apical half, the outer margin rather broadly rounded, projecting at the tip of the upper median nervule into a moderate rounded tail, tapering at the base, longer than broad, and with a slight, rounded projection at the tip of the lower median nervule: inner border broadly expanded at the base, beyond straight nearly two-thirds of the way to the tip, then, receding suddenly but a little diagonally to a great distance, it resumes its former direction, and with a slight convexity passes to the abrupt, but well rounded anal angle. Precostal nervure bent inward, originating considerably beyond the divarication of the subcostal from the costal nervure; cell closed by a feeble vein.

Fore legs small, cylindrical, a little depressed, thickly clothed with a depressed, bushy bunch of long, somewhat spreading hairs, heavier in the male than in the female: the tibia slightly less than half as long as the hind tibia; tarsi of nearly or quite the length of the tibia, in the male consisting of a single joint, with exceedingly slight indications of divisions—one being marked by a slight constriction near the tip—and wholly unarmed; in the female distinctly composed of five joints, of which the first is three times as long as the others taken together, and these successively smaller toward the tip, each joint furnished at the tip beneath with a pair of very short, slender spines, the first joint with others along the under edge. Middle tibiae scarcely longer than the hind ones, furnished on either side beneath, and on the upper portion of the inner side, with a row of not very frequent, long and moderately stout, spreading spines, besides a few shorter scattered ones along the outer side, the terminal ones of the inferior rows developed into moderately long and slender spurs; tarsi with the first joint as long as the three succeeding ones together, the second and fifth equal, the third and fourth scarcely smaller, equal to each other: furnished with four (the last joint with two) rows of rather short and moderately stout spines beneath, and a few scattered ones above at the base of the first joint. Claws moderately slender, not large, tapering to a fine point, pretty strongly curved. Paronychial slender, tapering a little, as long as the claws, but curving less though regularly, finely pointed, a little incurved at tip. Pulvillus wanting. Last joint of tarsi furnished above with four excessively fine, long, aciculate spines, directed between the claws.

Abdomen short and stout, the upper organ of male appendages small, the hook much longer than the body, nearly straight, swollen on its basal half, equal beyond; its inferior arms as in *Eugonia*. Clasps very broad and short, much longer above than below, with the upper basal process very broad at base and tapering, much longer than the clasp, directed much as in *Eugonia* but not so elevated; interior finger slender, tapering, directed upward and backward, not nearly so long as in the preceding genera.

Egg. Broadest at base, narrowing slightly above, higher than broad, the summit broad, distinctly marked, only slightly convex, the base broadly docked and externally rounded. It is furnished with a few rather prominent, compressed, regular, equidistant, longitudinal ribs, commencing below the broadest part of the egg and increasing a little in height, turning abruptly at the edge of the summit, where they are highest, and extending half way to its centre, terminating rather abruptly; surface between the ribs slightly flattened, especially on the upper half, and broken into cells by delicate raised crossed lines. Micropyle formed of nearly uniform, crowded, roundish cells.

Caterpillar at birth. Head smooth, well rounded, even, very slightly and angularly prominent in the middle of the sides, where it is broadest, considerably broader than high, with a few pretty long hairs. Body nearly uniform, tapering very slightly, armed with longitudinal rows of very long, nearly straight, very delicate, tapering hairs, seated on minute warts; these are arranged on either side in a subdorsal (becoming laterodorsal on the second thoracic segment, and absent from the first), one to a segment placed scarcely in advance of the centre, a supralateral, one to a segment placed behind the middle, a laterostigmatal, one to a segment placed in the middle, a stigmatal, one to a segment placed on the posterior portion, and an infrastigmatal row, one wart to each segment placed on its anterior portion. Legs pretty long and not very stout, tapering, the claw with a large, tapering, basal, interior process, itself moderately long, tapering, very strongly bent and slightly curved. Hooks of the anterior prolegs seven in number, tapering, and very strongly curved.

Mature caterpillar. Head not very large, subquadrate on a front view, the sides being very broadly rounded, almost flat, the summit hollowed a little at the middle suture, the apices of each half a little tumid; a little full about the ocellar field, broadly appressed in front, the triangle scarcely sunken, the head hardly deeper below than above, covered all over, but especially on the tumid summits and the hinder portions, with a large number of short, stout, conical, blunt tubercles, and more frequent minute ones, the latter emitting each a short hair; triangle more than half as high again as broad, the sides slightly curved, scarcely extending more than half way to the summit. Antennae with the basal joint scarcely exerted, the second half as long as broad, stout, the third half the diameter of the second, fully thrice as long as broad, the fourth very small. Ocelli six in number, five arranged in a moderately broad curve, its convexity forward, the middle three at equal and very slight distances from each other, the first removed from the second, and the fifth from the fourth by their own diameter; the sixth is situated at a little distance behind at equal distances from the first and fourth, with which it forms a right angle; all equal in diameter, the second to the fifth very protuberant. Labrum very small, deeply excised in the middle. Mandibles moderately large, stout, angulated, the edge straight, entire, above with some scarcely impressed lines. Maxillary palpi exceedingly small, not at all exerted. Spinneret small, conical, tapering.

Body cylindrical, nearly equal on the abdominal segments, the thoracic segments tapering somewhat forwards, armed with quite long, stout spines, each one tapering regularly to a fine point, and bearing a few minute, short, needle-like thorns, scarcely visible to the naked eye, and often, generally above the middle, one, two, or three little short spinules, tipped with a short thorn; these spines are arranged in longitudinal rows, one to a segment in each row as follows: a dorsal series, placed anteriorly on the third to the eighth abdominal segments; a laterodorsal series, placed a little in advance of the centre of the first to the eighth abdominal segments; a supralateral series, placed

similarly on the second and third thoracic segments; those of the last two series are somewhat larger than the others; a laterostigmatal series, placed similarly on all the abdominal segments; a stigmatal series, placed centrally on the second and third thoracic segments; and an infrastigmatal series, placed centrally on the first to the eighth abdominal segments. The body is abundantly supplied with minute warts, and profusely furnished with still minuter ones; the former emit short, delicate hairs, and on the posterior parts of the segments are arranged in transverse rows. Spiracles small, obovate, less than twice as broad as long. Legs rather slender, tapering, the posterior pair long, the others rather short, the last joint compressed; the claw small, a little curved, compressed, heavily beaded at the base. Prolegs long, rather stout, tapering considerably, with a multitude of hooklets, closely crowded in more than a single row around the inner two-thirds of an oval, the hooklets slender, nearly equal, not curving greatly.

Chrysalis. Viewed from above the head and prothorax taper very slightly as far as the base of the ocellar tubercles, the outer edges of which are parallel; ocellar prominences conical, their inner edges inclined toward each other at a little more than a right angle, the space between them squarely docked; on a side view, the under edge is continuous, or nearly so, with the under surface of the appendages, slightly curved downward at tip; the upper edge is continuous with that of the prothorax, forming an angle of about fifty degrees with the lower edge. The mesonotum is greatly arched longitudinally and carinated along the middle line, the carina rapidly and regularly elevated just behind the middle to a great height, forming a projection which is highest posteriorly, half as high as long, with sloping sides placed at an angle of about thirty-five degrees with each other, and posteriorly falling almost perpendicularly to the general curve of the segment. Inferior surface of the body, including all the appendages, forming an almost exactly straight line from the tip of the ocellar prominences to near the tip of the wings, where it slopes upward. The middle of the mesonotum is also furnished with a pair of small, supralateral, rounded, conical warts, as high as broad; basal wing tubercle and supernumerary tubercle much as in *Polygonia*, separated by a rather deep, somewhat angular excision; wings protuberant in the middle of the upper half of the posterior border and elevated into a blunt, conical tubercle, making the body here as broad as at the supernumerary tubercle; metanotum with supralateral tubercles similar to those of the mesothorax. Abdomen shaped as in *Polygonia*, furnished with a dorsal series of low, small, conical warts on the anterior edges of the third to the eighth segments; a series of greatly elevated conical tubercles, the tips of each produced to a sharp, hard point, each perpendicular to the surface on which it rests, arranged in a laterodorsal line on the centre of the second to the eighth segments, that of the third segment considerably larger than the others, directed slightly backward, that of the eighth diminutive, scarcely produced at tip; the first segment has a pair of small, rounded, laterodorsal warts, placed anteriorly; there is also a series of small, low, rounded, suprastigmatal warts, placed a little in advance of the middle of the second to the ninth segments; and an infrastigmatal series of similar warts in the middle of the fifth to the eighth segments. Preanal button bounded by a low, coarse, corrugated, equal, slightly curving, longitudinal wall, terminating anteriorly in a stout, irregular, subspherical tubercle; cremaster posterior to it deeply hollowed; it is corrugated throughout, above hollowed broadly but shallowly, the bounding wall very thick at base, slender beyond; on a dorsal aspect it is considerably longer than broad, tapering somewhat to a well arched tip; viewed at the side it is nearly equal, a little broader at the base, the apical field of hooklets circular and small. Hooklets long, slender and straight, until close to the tip, where each is rather suddenly and considerably enlarged into a strongly curving club, the end produced to a blunt tip, directed toward the base.

Synonymy. As I have shown in my Historical sketch of the genera of butterflies, the laws which govern the stability of names in zoology, if

logically carried out, would compel us to restrict the old Linnean name of *Papilio* to this butterfly and its congeners. This I have done since I first pointed it out in 1872 (*Syst. Rev.*) ; but no one has seen fit to accept a logic so severe, although no attempt has been made to controvert the points raised, so far as regards the history of the name since 1758, where its history properly begins. The virulent sentimental objections that have been raised to its restriction to this group and its removal from one where common usage has placed it, and the fact that such removal would, by the rules I have adhered to in the present work, carry with it also the family name, induce me, in injustice to Schrank, and against my judgment of what would really be best and finally permanent, to leave *Papilio* where it is, and has been, best known. It becomes, therefore, necessary to introduce a new term for the present group, which I have accordingly done.

Geographical distribution. This genus consists of only two known species, one of which, *E. cyanomelas*, is reported from Mexico alone, while the other, the species described below, has a much more extensive range, including Mexico and embracing the larger part of the north temperate zone. Its distribution in America appears to be greater than in Europe as far as regards differences of temperature and climate ; and this fact, together with the occurrence of a distinct type of the genus, as here restricted, in North America alone, have long led me to consider this continent as the proper home of the widespread antiopa. Walsh long ago argued (*Proc. ent. soc. Phil.*, iii : 219) that it must have been introduced into this country, if at all, from Europe and not from England, because our specimens agreed with the continental and not the anglican type, but his argument was based on the supposition (wholly gratuitous and utterly improbable) that it was transported in the egg state on growing plants. The presence of the Mexican species seems to me to put its introduction (if introduced at all) back into geological time ; while the larger number of near allies in the Old World than in the New (i. e., of species of *Nymphalis* in the sense in which it is used in Kirby's catalogue—excluding the *Polygoniæ* proper) tends toward the opinion that its earlier ancestors were Asiatic. I may here quote from a letter received from Dr. Behr of San Francisco, on receipt of my paper on the distribution of *Vanessa cardui* (*Am. nat.*, x : 392), presenting a curious bit of evidence for its probable American origin. "There is another *Vanessa*," he writes, "which may perhaps be of American origin. It is antiopa. I am led into this belief by the circumstance that old missals decorated by monks in mediaeval times with life-like insects and flowers, show frequently *V. io*, but never *V. antiopa*, whose striking beauty certainly would have inspired the mediaeval college father with the same desire to ornament with its figure the missal under his hands."

Characteristics and history. The butterflies of this genus are

moderately large in size and nearly black in color, darker above than beneath, the under surface profusely streaked with short, transverse, slender threads of black; the outer margin has a broad border of some brighter color more or less marbled; small, transverse, pale bars depending from the costal margin of the fore wings at one-half and three-fourths the distance from the base indicate an affinity with the butterflies of the neighboring genera. We know the history of only one species; in this there are usually two broods of butterflies, one appearing in July and the other in September, the latter hibernating. In northern localities, however, there is apparently only one brood, appearing in August; while the south, on the contrary, will probably be found to produce three broods annually. The butterflies have a bold active flight and frequent sunny openings in light woods.

The eggs are somewhat barrel-shaped, a little higher than broad and furnished with seven or eight rather prominent strongly compressed ribs; they are laid in clusters, partially embracing the terminal twigs of the plants on which the larvae feed. The larvae are social, those from each cluster of eggs living in company throughout this stage of their existence. When just from the egg, they have a smooth head furnished with a few very long hairs, and a cylindrical body supplied with eight rows of minute warts (two of which are below the spiracles), each giving rise to a long, straight, slender, tapering hair. The mature caterpillars have a somewhat similar head and a cylindrical body, the thoracic segments of which taper forward; the body is furnished with one dorsal and three pairs of lateral rows (two above and one below the spiracles) of long, tapering, thorny spines; the dorsal series is wanting on the thoracic and first two abdominal segments. The chrysalis is strongly angulated and furnished with rows of conical tubercles, all of which, as well as the other prominences, are rather sharply pointed; the dorsal protuberance of the mesothorax is nearly as high but not so compressed as in *Polygonia*, and, as in that genus, the body is much strangulated dorsally between the thorax and abdomen. Excepting by Hübner, the genus *Inachis* has always been intimately united to this, although the butterfly differs so remarkably in coloration, and the caterpillar is wholly destitute of the dorsal spines.

EXCURSUS XI.—BUTTERFLY SOUNDS.

Hast thou heard the butterflies
What they say betwixt their wings?

TENNYSON.—*Adeline*.

It has long been known that some South American butterflies during their flight give utterance to peculiar clicking sounds, but it is far less known that such noises are made by our own butterflies; we shall

hope to show that it is not improbably a common feature in the life of butterflies. The first account of the noises made by butterflies (belonging to the genus *Ageronia*) appears to be that given by Darwin in his celebrated *Journal*, who states that "several times when a pair, probably male and female, were chasing each other in an irregular course, they passed within a few yards of me; and I distinctly heard a clicking noise, similar to that produced by a toothed wheel passing under a spring catch. The noise was continued at short intervals, and could be distinguished at about twenty yards' distance" (pp. 33-34). But the most interesting account we have seen of these sounds is that given by Mr. Bigg-Wither. This butterfly, which he and his friends christened the "whip butterfly," is said by him to settle upon the boles of trees, head downward and wings outspread, closely embracing the bark. "In this position, which is more common to moths than to butterflies, it remains undetected by the casual observer, as it resembles merely a patch of lichen. If approached, however, it will give warning of its disapprobation by sharply shutting and opening its wings once or twice (more generally twice) in quick succession, producing by this sudden contact the whip-like snap from which we gave it its name." One notices exactly this *movement* in many of our temperate *Vanessidi*, when half alarmed. "Frequently, too, it makes the same sound when on the wing. The *surugúá* [a bird with a sharp beak and abnormally big mouth] is very partial to this butterfly, and is at once attracted by the whip-like crack, forsaking its branch on which perhaps it has been perching for half an hour without having given the smallest sign of life, and darting after the 'whip-cracker' with great eagerness." (Pioneering in South Brazil, i: 306.) He even states that the bird frequently alights upon a tree trembling under the blow of the axe, the vibration of the leaves caused by the strokes of the axe deceiving it in imagining that butterflies are flitting about it. Mr. Walker (*Ent. monthl. mag.*, xix: 26) states that when these butterflies are approached after alighting they start off at great speed, "making at the same time a loud and most singular snapping or crackling noise, which I can best compare to the sound of a slight electric spark, at intervals of one to five seconds. This sound is particularly distinct when the male is chasing the female and I have heard it at a distance of at least ten yards. I think it is produced by both sexes." Wallace observed the same thing at Para and believed that it was produced in some way by the contact of two insects, as he only heard it when two insects were chasing or frolicking with each other, and it seems to be the general belief that the sound is common to both sexes, which Mr. Van Volxem positively asserts.

But, as stated above, these sounds are emitted also by butterflies of the temperate regions. Thus Mr. Swinton, who has written a good deal upon this subject, states that *Aglaís urticae*, about to hibernate and in a drowsy

condition, was induced by him to depress and shut the wings successively, and "each time she testily performed this action I heard distinctly, as the fore wings were brought forward, when only the extreme basal portion of the wings was in contact, a sound soft and refreshing, like evening footsteps on the pavement, or grating sand-paper." The same thing has been observed long since by the Rev. Mr. Green in the European *Inachis io*, who accidentally disturbed a colony of hibernating butterflies and heard a faint hissing noise issue from the cavity in which they were concealed, while the wings were slowly depressed and elevated; the noise resembled "that made by blowing slowly with moderate force through the closed teeth." The late Mr. Hewitson of England also observed the same thing in *Inachis io*, but compares the sound of the wings when rubbed together to the friction of sand-paper. Mr. A. H. Jones (*Ent. month. mag.*, xiii: 208) noted the same thing in hibernating *Euvanessa antiopa*, which produced a grating sound, and I have myself not only heard this butterfly make the noise while fanning its wings as it rested upon a window sill, but have artificially produced the same sound by rubbing the wings of a dead specimen together.

Other butterflies, but tropical species, are also stated to produce such sounds. Thus Distant gives the observation of a Captain Godfery as noticing that one of a pair of a species of *Thaumantis* (a genus allied to the great blue *Morphos* of South America), while flying around its mate "produced a most curious crackling or rustling noise," which "was evidently emitted at the creature's will and was distinctly audible within two or three yards of the insect" (*Rhop. Malay.*, 426-27). Fritz Müller, who adds his testimony to the clicking sound emitted by *Ageronia*, states that quite another butterfly, a species of *Eunica*, equally produces the noise, and he also heard a sound, even louder than that made by *Ageronia*, "produced by two small brown butterflies which I did not succeed in catching."

The sounds made by butterflies of the temperate zone and compared by nearly all observers to that of the abrasion of one rough surface upon another, more or less faint, would hardly seem at first sight to be entirely analogous to the clicking sounds made by their more noisy brethren of the tropics; but no organs can be found in the one which do not exist in the other. Now experiments made after death upon *Polygonia faunus* show that they must be capable of producing the same sounds as *Euvanessa antiopa*; and in this connection, an instance which occurred to me last summer on the top of Mount Washington has a direct bearing; for while walking on the carriage road, I started up a pair unobserved just at my feet. I instantly stopped motionless to see whether they would settle again, when one of them, which had flown to a short distance, turned and flew rapidly back straight at my face, turning only when within three or

four inches of my nose, and then suddenly whisking off with a distinct *click* at turning.

All the instances thus far given relate to the family Nymphalidae, and therefore the following instance recorded by Rev. A. E. Eaton of England, is of unusual interest. He states (*Ent. monthl. mag.*, xix: 89) that he heard *Parnassius apollo* make a rustling noise by "slowly flapping her wings" while clinging to a flower, "and scraping the hinder pair with her four posterior legs, which were thrust backwards simultaneously each time that the wings opened"; it continued to do this even after the *front* wings were firmly held, but stopped when the hind wings were seized.

The only persons who seem to have endeavored to discover the cause of these sounds are the late Mr. Doubleday and Mr. Swinton. Mr. Doubleday examined the species of the genus *Ageronia* in the British Museum in vain for any sufficient cause drawn from the external structure of the animal. He found certain peculiarities, one of them a cavity on the under side of the upper wing near the region of the costal nervure, and another in the swollen part of the costal nervure of the same wing, both of them parts not covered by the hind wings in flight. He rightly disclaims any attempt to discover "a connection between either of these peculiarities in structure and the sound produced by the insect." Mr. Swinton, however, in several places has attempted to show that the base of the anal veins of the front wing in the stridulous *Vanessidi* and in *Ageronia* has a certain structure comparable to a file or lima, parallel indentations or slight striae being seen across its surface under a strong magnifying power. But this explanation can in no way answer, because an exactly similar feature may be found in all the other veins of all these butterflies, there being nothing distinctive in the veins themselves, either in the front or hind wing, in the regions which naturally overlap. When one examines, however, the *Vanessidi* of the temperate regions, he will discover that the hind wings are in many cases furnished not only with scales but with long, pointed bristles, and I at first thought that these bristles might be the cause of the sounds, although they seemed to be just as abundant in other parts of the wing as in those which were naturally covered by the opposite wing. Not having at my disposition any specimens of *Ageronia* at the time these observations were made, I requested Mr. Butler of the British Museum to examine the wings of *Ageronia*; but he found upon them no bristles whatever. If, however, one will examine the surfaces brought into contact between the two wings in the insects known to produce audible sound, he will note that nearly all the scales on the under surface of the front wing and those on the upper surface of the hind wing next the base, that is, in just those portions of the wing which overlap each other, are *much smaller and more erect* than in any other part of the wing, even than those in the immediate vicinity, and by experiment can show that when

these portions of the wing are rubbed together a noise is produced ; while in other butterflies, such as *Brenthis*, not nearly so much contrast appears. On examining these surfaces in the wing of a species of *Ageronia* in the Cambridge Museum, where I was kindly permitted to dissect one specimen, these scales were found to have in addition a more or less conical shape, as if to make the sound produced by their rubbing upon their mates more intense, but of course it would be impossible to imitate the "click" by any clumsy action of the hand.

Many observers have noted the peculiar movements of the wings of butterflies which are not accompanied by audible sounds, especially in the family *Lycaenidae*, where the hinder wings alone, erect when the insect is at rest, are rubbed together in a curious way, giving them "the appearance of revolving disks," as Mr. Wallace calls it ; and many observers have attempted to discover whether any sound followed this motion, but none have succeeded in doing so. Yet any other explanation of the intent of the movement would seem to be almost out of place, inasmuch as it is invariably made by certain species, including many of our own native kinds, directly upon alighting and at a time when there may well be no other butterflies in sight.* Movements of some sort are made by a large majority of butterflies ; as for instance in most of our *Argynnidi* and other *Nymphalinae*, which gently wave their wings upward and downward upon alighting, as if panting from their exertions. A marked instance of this is seen in *Vanessa atalanta*. Still more striking instances are the quivering movements of the male settled beside the female ; or of a butterfly eagerly sucking a flower when another alights beside it, and is thus warned to "keep its distance." These motions I am inclined to regard as movements for the sake of producing sound, though the sounds are inaudible to our ears. It is probable that this is on account of their faintness. There is a limit of human perceptibility of sounds from their shrillness and also from their feebleness. It is known, but perhaps not well known, that there are a certain number of saltatorial *Orthoptera* which can be *seen* to stridulate but whose sounds are inaudible to our ears. (Compare Yersin on the stridulation of *Orthoptera*, Bull. Soc. Vaud. sc. nat.) From the fact that certain butterflies produce sound during certain movements, we can hardly fail to believe that other butterflies making the same motion also produce sound, although inaudible to our ears.

Nor are the sounds made by these friends of ours altogether limited to the butterfly state, a large number of caterpillars making sounds by striking their heads against the leaf upon which they are resting, or by swinging the head from side to side, catching the mandibles in the roughnesses of the leaf or upon the silken strands which they have spun upon it, to produce a scraping sound to drive away intruders ; and Schild (Stett.

*The mechanism of this presumable stridulation is discussed further on under the *Lycaeninae*.

ent. zeit., xxxviii: 86) states that the chrysalis of *Callophrys rubi* when disturbed produces by its movements a slight sharp chirp, or as Klee-man called it in 1774, a clicking noise. But though I have seen many chrysalids of Nymphalidae in excessively active motion, I have never observed any sound from this source.

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See Swinton's two papers on stridulation in the genera *Vanessa* and *Ageronia* (Ent. month. mag., xiii,—1877), and the section on stridulation of the Lepidoptera (pp. 112-127) of his work entitled *Insect Variety*, published in London (without date) in 1880.

EUVANESSA ANTIOPA.—The mourning cloak.

[The mourning cloak (Auct.): Trauermantel (Germ.): Camberwell beauty (Engl.): Morio (French): antiopa butterfly (Harris): willow butterfly (Emmons): antiopae vaness (Emmons): yellow bordered butterfly (Maynard): white-border (Engl.): grand surprise (Morris).]

Papilio antiopa Linn., Syst. nat., 10th ed., 476-477 (1758);—Abb., Draw. ins. Ga. Brit. mus., vi: 87, figs. 24-25: xvi: 27, tab. 5 (ca. 1800);—Scudd., Butt., 98, figs. 23, 24, 27, 49, 81, 137 (1881).

Aglais antiopa Dalm., Kongl. vetensk. acad. handl., xxxvii, 64-65 (1816).

Eugonia antiopa Hübn., Verz. schmett., 37 (1816).

Vanessa antiopa Ochs., Schmett. Eur., iv: 17 (1816);—Boisd.-LeC., Léop. Amér. sept., 173-174 (1883);—Harr., Ins. inj. veg., 3d ed., 296-298, figs. 121-123 (1862); Entom. corresp., 280 (1869);—Kirb., Faun. bor.-amer., iv: 293-294 (1837);—Emm., Agric. N. York, v: 20-21, pl. 6, figs. 5-7 (1854);—[D'Urb.], Can. nat. geol., ii: 93-96, fig. 1 (1857);—Morr., Syn. Lep. N. Amer., 57 (1862);—Linn., Proc. Entom. soc.

Philad., iii: 59-61 (1864);—Saund., Can. ent., i: 75-76 (1869);—H. Edw., Pac. coast Lep., ii: 9-10 (1873);—French. Rep. ins. Ill., vii: 153 (1875); Butt. east. U. S., 103-105, fig. 54 (1886);—Middl. Rep. ins. Ill., x: 85 (1881);—Coq., ibid., 163 (1881);—Fern., Butt. Me., 57-58, fig. 19 (1884);—Mayn., Butt. N. E., 16-17, pl. 2, fig. 18, 18a (1884).

Hamadryas angulata antiopa Hübn., Verz. eur. schmett., 2 (1822).

Nymphalis antiopa Latr., Hist. nat. crust. ins., xiv: 83, pl. 105, fig. 1 (1805).

Papilio morio Reitz., Gen. sp. ins., 31 (1783).

Figured by Abb., Draw. ins. Geo. Oemler Coll. Bost. soc. nat. hist., 13;—Glover, Ill. N. Am. Lep., pl. 1, fig. 12; pl. 21, fig. 27; pl. 33, fig. 1; pl. 92, fig. 20, ined.

Look you, the worm is not to be trusted but in the keeping of wise people; for indeed, there is no goodness in the worm.

SHAKESPEARE.—*Antony and Cleopatra*.

...strips the trees.

Eats the life out of every luscious plant.

And, when September finds them sere or scant,

Puts forth two wondrous winglets, alters quite,

And hies him after unforeseen delight.

BROWNING.—*Sordello*.

Imago (2: 4; 11: 2). Head covered above with a profuse admixture of dark brown, fulvous, white and black hairs, the latter longer than the others: at the base of the antennae is a tuft of dull, pale yellow hairs: there are many straw yellow scales behind the lower part of the eyes and a few skirt the upper part also, backed by dark brown scales. Palpi pale dirty straw yellow, with a slender streak of blackish down the middle of the sides of the basal half and a similar streak along the upper edge of the sides of the apical half, the last joint and much of the rest infuscated, the long spinous hairs which fringe the palpus above and below black, with pale yellow, black tipped apices. Antennae blackish brown, the inner side of the stalk and base of the club touched, especially on the basal half of the joints, with white: beneath, excepting near the

base and on the club, dark, dull castaneous; three apical joints of club, equally above and below, luteous. Tongue pale luteous, the apical half dark luteous; papillae indian-club shaped, about five times as long as broad, appressed, truncate and cup-shaped at tip, the central filament slender, bluntly pointed, half as long as the width of the papilla, the edge of the cup with four or five thorns half as long as the filament; not crowded, with room for twice the number in the space occupied, which is about the apical seventh of the tongue.

Thorax covered above with fulvo-maroon hairs and below with coarser white, or yellow tipped black hairs; fore legs black, covered with similar hairs; femora of other legs dark fuliginous brown, enlivened above and at tip with some pale yellowish brown scales; tibiae and tarsi wholly pale yellowish brown, the tarsi growing a little dusky toward the tip; spurs red, tipped with black; spines black, claws dark red, paronychiae blackish.

Wings above dark, rich maroon, ornamented with black, blue and yellow; on the *fore wings* the maroon verges toward black or blackish brown along the costal border, above the subcostal nervure and its first inferior branch; the costal edge and the whole margin to the costal nervure on the basal half of the wing largely flecked with short, slender, broken, transverse lines of straw yellow; at the tip of the first superior branch of the subcostal nervure a small, transverse, yellowish spot depends from the costal margin just crossing the black area, and directed slightly outwards: further on, midway between this and the apex, is a similar spot, equally narrow and having a similar direction, which reaches the first inferior subcostal nervure, sometimes attenuated below; directly beyond this spot commences a transverse, equal, black band, having strongly crenulate borders, slightly narrower than the marginal band and subparallel to the outer margin; it encloses, in each of the interspaces which open on the outer margin, a not very large, longitudinal, suboval or subtriangular, dark, caerulean blue spot, broadest outwardly; outer margin for fully the width of an interspace pale straw yellow (in hibernated specimens whitish), largely flecked, especially on the upper half of the wing, particularly in the neighborhood of the nervules, and most of all at the dentation of the wing formed by the prolongation of the first inferior subcostal nervule, with exceedingly short, transverse, irregular threads of blackish brown, frequently mingled on the dentation with pale bluish scales. Fringe at the nervure tips blackish, marked with dirty brown, on the interspaces whitish flecked with dirty brown. *Hind wings* with the maroon base less deep than on the fore wings, being more or less specked with dark brown: the black submarginal band encloses blue spots similar to, but usually larger than, those on the fore wings, and is itself broader than on the fore wings and broader than the marginal band, tapering toward either end, its own borders less crenulate than on the fore wings, sometimes nearly regular; outer margin similar to that of the fore wings in color and width, but narrowing toward the anal angle, flecked, especially (as a general thing) in the median area, with transverse, rather short, irregular threads of blackish scales, coarser and more distinctly separated than on the fore wings, less profusely and generally distributed, but still more abundant upon the nervules than elsewhere, and nearly concealing the yellow at the extremity of the upper median nervule, which forms the dentation. Fringe white, occasionally flecked lightly with dusky at the nervure tips.

Beneath, very dark plumbeo-metallic blue, profusely streaked with short, transverse, straight, black lines, composed irregularly of from one to three rows of scales, and enlivened very slightly with scattered dull, pale ferruginous, whitish and pale straw yellow scales, collected to a certain extent in delicate clusters, and generally found in the immediate vicinity of the nervules: scattered over all the wings, but more abundantly on the hind pair, and nearly absent from the lower half of fore wings, are infrequent, long, longitudinally recumbent, blue black, spinous hairs, tipped with yellowish brown. On the *fore wings* the two costal spots of the upper surface appear, but less distinctly, and of a grayish white; the marginal band is of the same width as above, but is here preceded not by a black band and blue spots, but by a strongly crenate, slender, equal, inconspicuous stripe (corresponding in direction to the exterior margin of the black band of the

upper surface) of disconnected, dark metallic blue scales on a black base; marginal band sordid white, heavily flecked, especially down its middle and particularly at the dentation of upper half, with short, more or less connected and blended, transverse streaks of black, dark plumbeous and dull dark bluish scales, most conspicuous in the upper half of the wing; at either side, but especially outwardly, the band is washed with very pale yellowish and externally with pale yellowish brown. Fringe white, broadly interrupted at the nervure tips, especially in the upper half of the wing, with pale slate brown. *Hind wings* closely resembling the fore wings in the submarginal, strongly crenate stripe of bluish scales, and in the outer border, the dentation of the upper median nervure being similar to the upper dentation of the fore wings. The base of the wings is similar, but the transverse black lines collect to form slender, rather indistinct, often obsolete stripes, one crossing the middle of the wing in an irregular course, the other, less distinct and generally present only in the middle of the wing, lying midway between the first and the marginal band; on the lower half of the wing the spinous hairs are not recumbent. Fringe whitish.

Abdomen above black, the base with many maroon hairs, beneath dirty yellowish white or yellowish brown, with intermingled black hairs tipped with brownish yellow, the last segment usually blackish. Male appendages (33: 27, 28): upper organ; hook narrowing rapidly before the middle, but a little rounded, beyond a little compressed, tapering, very bluntly pointed, but little curved. Clasps about two and a half times broader than long, the posterior edge roundly and broadly excised on the upper half, the upper outer angle produced a very little, slightly angulated, slightly incurved and delicately covered with prickles at the edge; upper basal process compressed a little, sulciform, the inner edge a little thickened, roundly bent at a right angle at the middle of its basal two-thirds, the outer border similarly bent at the base, up to this point equal, beyond tapering rapidly to a little produced, arcuate and finely pointed apex; it is nearly four times as long as the breadth of the base, directed at first backward and considerably upward and bent a little inward, beyond directed backward and curving inward; interior finger finely pointed, nearly straight, and reaching the edge of the outer border of the clasp at the lower portion of its excision.

Measurements in millimeters. Length of tongue, 13.5-14.5.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	31.	37.	39.	32.	44.	44.
antennae	14.	17.	17.5	14.2	19.5	19.5
hind tibiae and tarsi..	9.	11.25	11.5	10.	12.	12.
fore tibiae and tarsi..	4.4	5.	5.5	4.2	5.5	5.5

Malformations. Dr. Hagen has published (Mem. mus. comp. zool., ii, No. 9) a curious instance of a Brazilian butterfly (Morpho) bearing, instead of its own proper head, that of its larva, and has referred to several similar freaks of nature, one of which, observed by Zeller in the present species, we quote in full from the original source (Isis, 1839, 259); "As a remarkable case of infrequent occurrence I may mention an antiopa which I raised, together with about one hundred and fifty others, and which bore, instead of the butterfly's head, a perfect head of the caterpillar. With this exception, the specimen is perfectly formed and differs in nothing from the ordinary summer brood. The head is perpendicular, as in the larva, and its mouth is closed; having broken a fragment from the ocellar field of the right side, I noticed that the shell in front and above was not connected with the interior, but was separated from it by a narrow space. Since a further investigation cannot be made without complete destruction, I leave it for another occasion. On the prothorax of the butterfly, behind this caterpillar head, and yet not connected with it, the two anterior plates (*Nackenshalen*) of the chrysalis are placed. This remarkable butterfly emerged in my absence at the end of July, and was impaled without further observations on its behavior. I could not discover its chrysalis among the mass of crushed skins."

I once took a specimen of this butterfly on the Boston Public Gardens, in which the tarsi of the right middle leg were quite useless, being curved outward, backward and a little upward.

Suffused aberrations. E. A. HYGLAEA (*Van. hygiaea* Heyd., Verz. eur. schmettt., 7. *Van. lintneri* Fitch, Trans. N. Y. agric. soc., 1856, 485. Figured by Mayn., Bntt. N. E. pl. 2, fig. 18b). The first specimen I saw of this variety was one from Albany, in the collection of Mr. T. L. Mead, the upper surface of which (excepting the mottled costal border of the fore wings) is uniformly maroon as far as the outer of the two yellow costal bars of the norm. and nearly as far as the inner edge of the blue spots of the norm; beyond this the whole outer portion is of the normal yellow, grizzled with brown, as in the upper part of the fore wing, normally; there is no inner costal striga on the fore wings; beneath there are similar peculiarities, with only slight traces of ferruginous on the outer edge.

Another specimen in the collection of Mr. W. D. Denton, and which he obtained on the wing at Chillicothe, Ohio, differs in that the yellowish margin of the hind wing is very much broader on the right side than on the left, being more than double the normal width and having a nearly straight inner margin, suppressing not only the black band which should border it upon the inner side, but also the blue spots included in this border. These blue spots are, moreover, wanting in all the other wings, excepting a few scales in the lower median interspace of all the wings and the upper median interspace of the left hind wing.

Mr. S. L. Elliott says (Science, ii: 353) that of 380 specimens of one brood raised by him twenty-five were varieties. "Two of the varieties were *lintneri*, from which all the blue had disappeared. The third had the primaries *lintneri*, while the secondaries had the usual blue spots. The fourth had the secondaries *lintneri*, while the primaries bore the blue spots. In the remaining twenty-one, the whole upper surface of the wings had a mottled appearance, showing that the colors had been disturbed. They retained the blue spots, but the spots were much smaller than usual." None of these could be looked at as typical *hygiaea*, unless the black band in which the blue spots occur had given place to yellow.

In the museum of the Boston Society of Natural History, there is a specimen (No. 476) of this butterfly, collected by the late Mr. C. A. Shurtleff in the neighborhood of Boston, which seems to belong to this variety but to vary much less from the normal form. The black, submarginal stripe of the upper surface of the wings is narrower than usual, and the marginal yellow band correspondingly broader, especially upon the upper half of the hind wings; the limit between the two is less sharply defined than usual and the same is true of the costal bars; the series of blue spots in the black band above and the zigzag bluish stripe below are visible only in detached, inconspicuous remnants.

Strecker (Cat. Amer. Macrolep., 135) notes briefly another suffused form, quite distinct from the above, in which the yellow margin of the upper surface is replaced by black.

Egg (64:26, 33). Laminate ribs, seven to eight in number, .045 mm. in height at the edge of the summit, leaving on the summit a free space, .31 mm. in diameter; surface glistening, smooth, broken by delicate transverse lines, .02 mm. apart, which become more prominent on either side of the ribs, forming buttresses for their support. Micropyle .09 mm. in diameter, consisting (67:3, 6) of a central circle .025 mm. in diameter, followed by two series of rounded polygonal cells, about half the outer row as large as the inner, the other half considerably larger, the inner ones averaging .012 mm. in diameter, separated by rather prominent ridges. The micropyle is followed directly by very large, transverse, polygonal or hexagonal cells, often stretching across from one rib to another, as the succeeding row always does, or rather to the slender, zigzag ridges which are the continuation of the ribs. Color when laid, pale olivaceous yellow, changing afterwards to dark yellowish brown, and just before hatching to inky black; ribs pellucid. Height, .88 mm.; breadth, .74 mm.

The development of this egg (63) is fully treated in the Introduction.

Caterpillar. *First stage* (70:12). Head (78:50) shining piceous with a few pretty long hairs; ocelli black; basal joint of antennae pale; mouth parts blackish, excepting the upper edge of labrum which is pale. Body dull brownish olivaceous, the first

thoracic segment infuscated; warts of the color of the body tipped with black; hairs exceedingly long, sometimes a little curved, brownish; legs dull luteous, the apical third blackish; prolegs of the color of the body, each with a moderately long hair projecting from the anterior portion of the base. Length of body, 2 mm.; breadth of body, .4 mm.; length of hairs on body, .4 mm.; breadth of head, .6 mm.

After eating a single night the bodies become plump and distended as if they had eaten to repletion; they also change to a brownish, olivaceous color, and have a wiry look.

Second stage. Head shining piceous, with a few not very long, curving, black hairs. Body yellowish brown, the first thoracic segment blackish; a dusky, straight, dorsal line and dusky, wavy, longitudinal stripes on the sides. The armature in this stage is intermediate between the juvenile and adult stages, consisting of small tubercles bearing each a curving black hair, arranged like the spines of the later stages. Legs blackish fuscous; prolegs yellowish brown, tipped with fuscous. Length, 6 mm.; breadth, .75 mm.

Third stage. Head shining piceous. Body black, mottled with dark gray, the dorsal stripe consisting of two contiguous, oblong, oval patches of dull ferruginous, separated either in whole or in part by a narrow line of black; the body is armed now with shining piceous spines nearly a millimetre in length, each bearing at tip a long, pale hair, and at the sides a few short, black hairs projecting directly from the spine and not mounted as afterwards upon spinules; hairs of first segment pale. Legs shining piceous. Length, 15.5 mm.; breadth, 2 mm.

Fourth stage. The fourth stage differs but little from the fifth and scarcely warrants a separate description. In it the dorsal spots are divided by the dorsal line which becomes obliterated in the last stage and the spinules of the spines (86:83) have not attained their normal size, although conspicuous.

Last stage (74:28). Head (78:51) dull, bronze black, the warts black, giving rise to white hairs, arranged to some degree in vertical rows converging toward the summit of either hemisphere; mouth parts black. Body velvety black, covered with white warts, often narrowly encircled with fainter white and giving rise to white hairs; the third thoracic and first to seventh abdominal segments with a large, dorsal, orange red spot reaching as far as the inner base of the laterodorsal spines; spines (86:84) bright, bronze-black, minutely wrinkled transversely, the hairs black. Legs (87:13) bright bronze black; prolegs (87:21) reddish testaceous, the hooklets reddish brown. Length, 50 mm.; breadth of body, 7 mm.; length of spines, 5.75 mm.; breadth of head, 4 mm.

The exact stage of growth of this caterpillar is easy to determine, for no matter what the size may be, however fostered by abundance or emaciated by insufficiency of food, there are certain structural features characteristic of each stage. In the first stage the body is armed with hairs arising from little warts, none of which are placed in a median dorsal series; in the second stage the body is furnished with similar hairs having an entirely distinct distribution, some of them forming a dorsal series. In the third stage the body is armed with spines, emitting little, bristly hairs directly from its sides without the intervention of spinules; in the fourth the spines are the same, but the lateral bristles are mounted on very short spinules scarcely longer than the width of the spine; while in the fifth stage the same spines bear long spinules, often nearly one-third of their own length, with apical thorns.

Chrysalis (83:51, 58, 59). Dark yellowish brown, more or less marked with blackish fuscous, often covered, especially on the thorax and appendages with a very pale, bluish gray bloom and often tinged with roseate; dorsal and lateral surfaces of ocellar prominences and the sides of the dorsal tubercles of mesonotum, streaked with black; basal joint of antennae and laterodorsal tubercles of mesonotum infuscated; abdomen dotted infrequently with blackish fuscous, the dots arranged somewhat in transverse rows; very obscure, infuscated, stigmal and ventral bands; sides and front of the basal half of the laterodorsal abdominal tubercles black, their apical half red tipped with black; smaller tubercles black; spiracles black with obscure lips; sides of the

cremaster black; wall of the preanal button luteous, bordered inwardly with blackish. Length, 25-28.5 mm.; breadth of ocellar prominences, 4-4.5 mm.; height of thorax, 9-9.75 mm.; breadth of body, 9.5-9.75 mm.; height of abdomen, 8.5-9.5 mm.

The above describes the usual form, but there frequently occurs an individual of a gray appearance, so different in general aspect as to merit a special description. Whole body speckled gray, formed by blackish fuscous spots and streaks on a livid white ground, the paler color sometimes tinged with faint purplish; the upper and most of the under surface of the ocellar prominences are black; the sides of the dorsal tubercle of mesonotum are also black, but the posterior flank and the superior edge are pale and from the anterior end a narrow, obscure, pale band runs toward either ocellar prominence, and from the posterior end a faint, interrupted, pale, dorsal streak extends over the abdomen; the apical half of the tongue is black and the nervure tips are marked by a pale dot; on the abdomen there is a broad, dusky, ventral band and a narrow, dusky, stigmatal stripe; the laterodorsal tubercles are black at base, red at apex, tipped with black; the other warts and tubercles are wholly black; the upper edges of the cremaster are pale, the lower black.

Geographical distribution (20:5). This butterfly is apparently distributed over the entire breadth of the northern hemisphere below the Arctic circle, as far as the thirtieth parallel of latitude. It is reported in the Old World from England* and northern Spain to Amoorland and Japan, including the Himalayas on the south in Sikkim and Bhutan. In the New World it extends from Alaska (Dall, Kennicott, Edwards) to the Athabasca region (Geffcken), Moose Factory (Weir), Labrador (Christoph, Möschler), and Newfoundland (Gosse); and from South Carolina (Gibbes), Georgia (Abbot), north Florida (Chapman) and Bermuda, "very rare; one specimen seen" (Jones), to California and Mexico as far as Cordova (Sallé), near Acapulco at an elevation of 2000' (Behr), and Oaxaca (Godman and Salvin). Godman and Salvin even obtained two specimens on the table lands of Guatemala near Antigua and Duenos, and Boisduval and LeConte state that it is found in Colombia! It occurs sparingly throughout the central plateau region of the United States, and is rare throughout the southern states.

It is found in nearly equal abundance through all parts of New England, flies to but does not breed on the highest summits of the White Mountains, and is nearly everywhere so numerous as to become positively injurious on account of the damage done to some of our choicest ornamental trees. There is no remedy but to destroy the caterpillars wherever seen, or the eggs if fortunate enough to find them.

Haunts. The butterfly may be found nearly everywhere, but is especially abundant in the neighborhood of woods, where it sports in sunny nooks, and in spring time may be seen "hovering in numbers about the sappy stumps of recently cut trees" (Saunders). In Switzerland it feeds up to a height of 2,500 feet.

Periodicity. Like many other butterflies, this is more or less irregular

* It has always been very rare in England and for the last generation has scarcely been seen, excepting in 1872, when hundreds were taken.

in its appearance, being vastly commoner in some years than in others. This has often been noted on both sides of the Atlantic. In 1886, for instance, it was much commoner in New England than in 1885, both around Boston, as observed by several, and in places as distant as Hallowell, Maine (Miss Wadsworth) and Stow, Vermont (Miss Soule). Mrs. Heustis observed its rarity in New Brunswick in 1878 (Can. ent., xi: 39). In England, Mr. Swinton has endeavored to connect its periodicity with the eleven-year cycle of sun spots, by tabulating the number of recorded captures for forty-four years in four columns of eleven years each, the table showing the following numbers of captures of antiopa in each series of four years, commencing with 1832, 1843, 1854, and 1865: 13, 1, 5, 79, 14, 3, 1, 7, 0, 5, 0,—but with indifferent success, as the maximum sun-spot period falls just between the maximum and minimum period of abundance, and the three years of minimum sun-spots show an aggregate of nineteen captures against an aggregate of eighteen for the three years of maximum sun-spots, a difference which is not worth discussing (Nature, xxv: 584). Certainly the first requisite of such an hypothesis should be the common superabundance of antiopa in given years on *both* continents, which no one has yet attempted to show.

Food plants. The caterpillars live principally upon willows (*Salix*), and will apparently eat any of the numerous species; poplars (*Populus*) of which they seem to have little choice, though they perhaps prefer the Balm of Gilead and Lombardy poplars; elms, particularly the American elm (*Ulmus americana*) and *Celtis occidentalis*, on which Mr. Beutenmüller has taken it. In Labrador, Möschler says they feed upon *Betula humilis*, but I have seen no other specification of birch as a food plant in this country, though it is always given as one of the resorts of the larva in Europe. Lang also gives nettle and Kaltenbach linden (*Tilia*) in Europe; I should think these errors, but that Mr. H. Edwards informs me that he has taken them on rose bushes in California, the leaves of which they stripped bare after the way they treat willows; so that some latitude of choice must be allowed them. Doubleday has stated that their favorite food plant in Europe is the willow and in America the elm, but the willow is generally looked upon here as equally the favorite, though the devastation of the elms on cultivated grounds may be a little more conspicuous. Abbot figures it upon *Salix nigra*.

Oviposition. One cluster of fourteen eggs, found by Mr. Trouvelot, was laid July 16 at 2 P.M.; the eggs were crowded rather irregularly and closely together (one lying on its side), and enclosed half the terminal shoot of a willow at the base of a leaf, most of them occurring upon the under surface of the shoot. Another, a much larger cluster (64:33), almost encircled a twig of elm, two millimetres in diameter, only the upper surface being free from eggs; they were disposed regularly, bearing a

resemblance to the egg-clusters of *Clisiocampa americana*, each row forming a nearly straight line along the stem, and the eggs of one row usually opposing the interspaces of the preceding series; there were ninety in all, in twelve rows, the longest row containing nine eggs; the mass was 7.75 mm. long and, including the stem, 2.75 mm. broad; these eggs, found by Mr. Clapp, were laid May 6, and presented by him to the Boston Society of Natural History; although immersed in benzine for two or three minutes, every one hatched. A third cluster, laid May 19, consisted of nineteen eggs side by side in irregular rows on one side of a terminal twig. The twig was cut off with a pair of shears and fell to the ground, the butterfly with it, and she only left the twig after it had reached the ground. The female during oviposition rested head downward with closed erect wings. A female in confinement laid one hundred and twenty-three eggs in several masses on the under surface of a willow twig. She lived eight days after it and still had numerous eggs in her body. A fourth instance was last spring on May 18, when Dr. George Dimmock was fortunate enough to observe in New Hampshire a female in the act of oviposition. She was seated on the tip of a twig of willow, head downward with outspread wings. The insect was probably frightened away before oviposition was completed, but she had already laid, by eleven o'clock in the morning, three clusters of eggs on this one twig, containing altogether over two hundred eggs. They were interrupted at both ends by the half-opened leaves, which evidently caused the separation of the mass into three parts, one of them containing sixty-four eggs, mostly arranged in six rows down the twig; another thirty-four, irregularly disposed; and a third more than one hundred, the last more nearly encircling the twig than the others and partly arranged in somewhat regular rows, though in no case could any row be traced regularly through the mass.

Their time of duration in general is from nine to sixteen days.

Habits of the caterpillar. In hatching,—an operation which often consumes half a day,—the caterpillars bite the shell only around the outer edge of the summit, sometimes leaving the prominent ribs until the last, and, when only one or two are left, force up the lid thus formed, usually tearing it quite off in their exit. They do not eat the forsaken shells, but, moving rapidly off, seek a leaf upon which they at once range themselves side by side in compact rows, their heads always thereafter remaining together at the edge of the eaten leaf. If placed separately upon the same leaf, they immediately range themselves side by side. When young they eat only the parenchyma; afterwards they devour the whole leaf excepting the principal veins; finally all but the midrib. They spin a sort of thin web (81:1) which Meyer Dür has compared to that of the European *Gastropacha lanestris*, enclosing the whole twig (but not the leaves) upon which they are feeding, nor ever leave this carpet nest until

the branch is stripped of its leaves, when they remove to a neighboring twig. They are generally found high up in the tree and remain social throughout their caterpillar life; for, although the leaves of the trees on which they feed cannot support a row of the full-grown caterpillars, they are still found in the closest possible proximity, following each other's footsteps, the branches upon which they are clustered borne down by their united weight. Their progress on a tree may sometimes be traced by the clusters of cast-off skins they have left in their track, the first on a leaf-rib, the others on a stem of one of the twigs; for they crowd together at the time of ecdysis as at others, and as they undergo their changes, at least the earlier ones, at nearly the same time these clusters of cast-off skins (which they never eat) remain to mark the steps of their progress. When the caterpillars have finished a repast, they retire to the stripped twigs and leaf-stalks for a siesta, where they place themselves almost invariably head downward and remain immovable for a long while, their head and first thoracic segment a little raised, so that the front pair of legs is lifted from the twig and directed forward, while the body hangs from the other legs and prolegs which thus have a backward direction.

Mr. T. G. Gentry gives the following picture of the occasional abundance of this insect, the caterpillars of which were being attacked by a large beetle:—

Although the destruction was on a singularly grand scale, yet hundreds of larvae remained to undergo their transformations during the latter part of August. The eaves of the buildings, . . . fence rails, and in short nearly every available place, were hung with the angular chrysalides. So numerous were the latter, that after the final metamorphoses had passed, the red fluid which was ejected by the tender and newly formed butterflies gave everything the appearance of having been profusely spattered with blood. The area subjected to the desolating influence of these larvae did not cover less than two acres of ground. (Proc. acad. nat. sc. Philad., 1875, 24.)

Dr. Harris says of this caterpillar (Ins. inj. veg., 3d ed., 297):—

It was formerly supposed that they were venomous and capable of inflicting dangerous wounds; and within my remembrance many persons were so much alarmed on this account as to cut down all the poplar trees around their dwellings. This alarm was unfounded; for although there are some caterpillars that have the power of inflicting venomous wounds with their spines and hairs, this is not the case with those of the antiopa butterfly*. The only injury which can be laid to their charge is that of despoiling of their foliage some of our most ornamental trees, and this is enough to induce us to take all proper measures for exterminating the insects, short of destroying the trees that they infest. I have sometimes seen them in such profusion on the willow and elm that the limbs bent under their weight and the long, leafless branches which they had stripped and deserted gave sufficient proof of the voracity of these caterpillars."

Dr. Kirtland also says: "The larva, which often feeds on the foliage of the lombardy poplar, excited strong prejudice some years since against such trees, from an erroneous belief that the tenant was venomous, like

*Harris elsewhere says that the species of this caterpillar irritate the skin, but I have experimented directly and have never been

able to experience any sensation from contact with them, more than any pointed object would give.

Cleopatra's asp." This popular prejudice led to the selection of the lines I have placed first at the head of the species.

Life history. The species is usually double-brooded, the butterflies of the later brood hibernating and appearing on the wing again in the following year,—the harbingers of spring. They come out of their winter quarters very early in the year,—the first of all our butterflies, often before the snow has wholly vanished or indeed the storms are over, but almost always with ragged wings, the yellow well nigh faded from the outer margin; they may be seen sporting in warm and sheltered spots, such as openings in woods or the neighborhood of buildings in which they may have hibernated, as early as the first of March, occasionally even on warm days in February; indeed they may be seen during any of the winter months when a succession of those warm days occurs, which seem characteristic of every New England winter; certainly it is reported as flying December 20 at Mt. Carroll, Ill. (Sc. news, i: 143); Mr. Clapp has seen them near Boston in January, and Dr. Sturtevant records one which lit on the snow in Framingham, Mass., on February 16, 1875, after six weeks of intense cold, and when the thermometer had not marked 26° F. all day (Am. nat., ix: 247).

They generally begin to grow abundant about the middle of April, when pairing is said to take place (European observations), and continue to fly until the end of May; indeed a few battered individuals may not infrequently be met with very early in June. Mr. Saunders has reported several captures about London, Ont., as late as the second week in June. I have seen specimens about Boston as late as June 13, and in the White Mountain region as many as three or four on the 17th of June; once I saw two worn specimens in the Connecticut Valley at Granby on July 1.

Although the butterfly may be seen so long in the spring, the eggs appear to be laid during a brief period only,—in the early days or middle half of May. These hatch at this season in from twelve to fifteen days and the caterpillars reach maturity the last of June; they remain in the chrysalis state at this season from eight to twelve days, usually about eleven, and the butterflies are disclosed early in July, the most advanced by the first of July or last of June (rarely by the 20th*), the mass by the 7th to 9th of July, or often not until the 12th, and they remain on the wing until after the next brood has made its appearance; the eggs are deposited very soon after the females are disclosed,—by the middle and probably during the latter half of July or later; they now hatch in about nine days, the caterpillars attaining maturity during the month of August. At this season, according to the observations of Mr. Lintner, the insects remain

*Mr. Lintner records one as coming out of chrysalis (which he now thinks he must have collected in the field that season) on

June 8, 1869 (Ent. contr., i: 49). Whether a wintering chrysalis or one of the same season it is equally surprising.

in the chrysalis state for sixteen days and the butterflies appear again early in September, sometimes by the first, usually not until the 6th or 8th; they continue to emerge from the chrysalis even to the first week in October* and remain upon the wing through October and, if the weather is favorable, the early part of November. Saunders says (Can. ent., i: 75-76) that "about the middle of June, the imago becomes very scarce, then disappears until the advent of the second brood *early in August*"; but I think there must be some mistake in this; for it is scarcely possible that the broods of this insect in London, Ont., correspond with those in the White Mountain district and similar regions with a limited summer, where there appears to be but a *single* brood, appearing about the end of the first week in August. The same, according to Fernald, is the case in central Maine. In the extreme southern states, on the other hand, there are probably three broods, for Abbot records the disclosure of a butterfly in Georgia on the 4th of May, eleven days in the chrysalis, and this certainly allows time for two more broods.

Hibernation. The butterfly hibernates late in the autumn. Gosse says, "one of the latest seen of all our butterflies." Harris states that he has found it "in midwinter sticking to the rafters of a barn," as Mr. Grote has since done, "and in the crevices of walls and stone heaps, huddled together in great numbers, with the wings doubled together above the back and apparently benumbed and lifeless; but it soon recovers its activity on being exposed to warmth." It may also be found singly in similar situations. Mr. Holden found a specimen in February on the underside of a board lying on the ground; and in Mr. Edwards's Butterflies of North America will be found an account of some found in the cavity of a tree. Siewers says "it is occasionally found in stone piles, but I think its most common hiding place is in the culvert walls of our country roads," and Caulfield "under stones on dry, sunny slopes, with scattered trees." De Garmo saw it select "the open end of a street drain built of stone. For two or three days it remained there, but a warm sun called it out and I tried to catch it. It was very active and alert, but finally went to its hiding place, where it felt so perfectly secure that I took it in my fingers with ease" (Trans. Vass. inst., ii: 132). I once found it hidden in the interior of a woodpile. In Europe, von Homayer says it selects corded wood in the forest.

But it is also a question whether some chrysalids of the autumn brood,—there at least where two broods occur,—do not also continue suspended throughout the winter and disclose the butterfly in the spring. Mr. Lintner in his remarks published many years ago upon this species, says of the autumn generation; "A portion only of the chrysalids of this brood—those

*On one occasion I found a full grown but starved caterpillar in Cambridge, September

26. It hung up the same day and emerged about the middle of October.

which were the first to reach that stage or such as may have had positions more favorable for their development—disclose their butterflies at this unfriendly season, when the cold autumnal winds so soon compel them to shelter themselves in winter retreats.” On writing to Mr. Lintner for confirmation of this assertion, he replies: “My statement seems as if I had carried some of the chrysalids through the winter to emerge in the spring, but I have no recollection of such an occurrence, nor do I find any record of it among my notes.” In accordance with his early opinion, however, are the statements of several correspondents that they have taken specimens in April apparently quite fresh, and as these butterflies almost invariably fly several weeks before hibernating, they would not be likely to appear very fresh in the spring; moreover, since, as above stated, the females of the early brood oviposit very soon after eclosion, those from wintering chrysalids would have an opportunity of laying their eggs at the same time as the hibernating butterflies and thus produce no confusion in the appearance of the broods. On the other hand, Gosse mentions (*Can. nat.*, 356) finding a pupa on December 25; and Mr. Saunders says he has “several times kept the chrysalids of this insect over the winter, but,” he adds, “they have invariably produced ichneumons in the spring”; and my experience has been the same. There is also a difference of opinion among lepidopterists concerning the hibernation of the species in Europe; Dr. Speyer thinks they winter only in the imago state; Dr. Meyer Dür says in his memoir on the Swiss butterflies that the first butterflies of the spring are those which have hibernated, but that others flying from the beginning of May until toward the end of June are disclosed from hibernating chrysalids; he has, however, since written me that he does not believe they winter as chrysalids. Herren von Prittwitz, Zeller and Wiesenhütter all speak of it as wintering only in the imago state, so that the balance of authority is decidedly against the hibernation of chrysalids. It is certainly not very creditable to the zeal of entomologists that this part of the history of a butterfly so common on two continents should be undetermined.

Wintering without hibernation. Experiments made within doors show the possibility of carrying this butterfly through the winter in the house. Mr. Siewers of Newport, Ky., placed one caught September 7 (*Can. ent.*, x: 115-116) in a paper box in a cold room where water would freeze, with half an apple in a small dish covered with sugar and filled up with water, renewed once a week.

It placed itself on the side of the box, directly over and within reach of the dish, and however I moved the apple I always found that it followed it around. It evidently fed on warm days, but never opened its wings. . . . It allowed me to handle it and would lie flat on my hand without movement. In February I thought there were symptoms of weakening. It no longer perched on the side of the box, but remained on the bottom, leaning over very much to one side. Placing it in sunshine the last week in February, it began to open its wings little by little, with short jerks. . . . When

half open it was put away again. On March 11, a warm, clondy day, I took it on my finger to an open window. . . . The sun suddenly shone out, and the next moment it was gone. . . . I found it four days after in a sugar camp. . . . I recognized it at once by a bad bend in the tip of the wings.

Mrs. H. P. Nichols made the attempt to keep one in an occupied room in Boston.

When I first had it, observing grapes suited its palate, I saved a few for a good while. After a time I thought my butterfly behaved as if intoxicated, tumbling down under the flower stand and greatly resembling the noble creature man under similar circumstances. It then occurred to me that the grapes had fermented, which I found to be the fact. Breakfasting on sugar and water it behaved like any well-conditioned butterfly, but a repetition of the grapes brought about the same results. As it sits upon my finger preparing to fly it makes a loud, humming sound while vibrating its wings. When the sun is bright and the room warm, it delights in flying about the upper part of the room. It folds its antennae on a line with the upper wing when asleep, and is as difficult to waken until it has had its nap out, as any sleepy school-boy. I think it knows me, for it is always ready to crawl upon my finger, from its warmth, perhaps, and seems to particularly enjoy resting on the palm of my hand.

Whether Mrs. Nichols carried the butterfly quite through the winter, I do not now recall.

Flight and habits of the butterfly. Its flight is strong and nimble; I once observed a specimen late in February from the deck of a vessel off Lookout Shoals, N. C., full twenty miles from land; it must have already braved the perils of hibernation; but though evening was fast closing in, it soon disappeared, pursuing its venturesome flight, undaunted still. It makes two or three light flutters in quick succession, then sails a short distance in an irregular and broken course; beats its wings again and thus pursues its way. It loves to return to a place whence it has flown, flying and sailing easily round and round in gradually narrowing and descending circles from a height of five or ten feet and finally settling upon the identical spot it had quitted, even when there is no apparent cause for attraction. When two friends meet, they soar aloft rapidly to a great height, alternately meeting and retreating. The butterfly often alights on the ground, writes Dr. C. S. Minot, broadside to the wind and allows itself to be blown over.

Mr. J. G. Jaek once observed several specimens "hovering over bushes of choke cherry, the leaves of which were much infested with aphides. The butterfly would alight on the curled leaves containing the aphides and extending its tongue, insert it among them, and when engaged drinking the sweets furnished by the aphides, it could readily be taken with the hand."

Mr. Saunders catalogues this butterfly as one which was attracted by night to the electric light in London, Ont., but he adds that he "did not see it in motion; it was in rather a sleepy condition, and may possibly have flown there by daylight;" but Mr. Henry Edwards has also observed it at the electric light in New York.

Mr. Lintner, writing of this butterfly, says :—

An interesting peculiarity of this species—not observed by me in any other diurnals* and not to the same extent among the nocturnals—is its habit of counterfeiting death. When newly emerged, within the breeding cage, it may be taken between the fingers without the slightest show of resistance; at the first touch it folds up its legs and becomes seemingly inanimate. Released from the hand, it drops upon its side and will even allow itself to be tossed from side to side without attempting flight. If left undisturbed for a short time, it slowly raises itself and simply resumes its upright position.

When at rest the wings are sometimes tightly closed, the costal edge of the hind wings reaching the lower median interspace of the fore wings; or more often, especially when in the sun, they are expanded horizontally, the inner margin of the fore wings reaching the lower subcostal nervule of the hind wings: in the former case, at least, the body is raised anteriorly “on tip toe” at an angle of about 30° - 35° , the anal angle of the hind wings resting upon the ground: the straight antennae are raised still higher, at an angle of 50° - 60° with the body and are spread at an angle of 30° - 35° . One chilly morning a butterfly was observed apparently partially benumbed with cold, walking with its antennae thrust horizontally forward, slowly and slightly raising and lowering its wings.

Miscellaneous. The resemblance to this butterfly of *Elymnias singhala* Moore of Ceylon is very singular and would reasonably be looked on as a case of genuine mimicry did the two occur in the same region.

E. antiopa is said to make a slight rustling noise with its wings and the same is stated of other butterflies closely allied to it. Rev. J. Green states (Proc. ent. soc. Lond., Feb., 1883) that he found hibernating specimens of *Inachis* io moderately active and making a slight hissing sound on being disturbed, at the same time slowly depressing and elevating the wings, giving the impression that this movement was the cause of the noise; the sound was similar to that produced by blowing slowly with moderate force through the closed teeth. We have elsewhere endeavored to show to what the sound is due,—probably to the character of the scales where the wings overlap.

Here are the comments of a careful observer of nature, who, however carefully he noted the movements of higher beasts or the habits of plants, has left us scarcely another trace of his being attracted by insects :—

March 28. 1857. At Lee's Cliff and this side, I see half a dozen buff-edged butterflies, *Vanessa antiopa*, and pick up three dead or dying—two together, the edges of their wings gone. Several are fluttering over the dry rock *débris* under the cliff, in whose crevices probably they have wintered. Two of the three I pick up are not dead, though they will not fly. Verily their day is a short one. What has checked their frail life? Within the buff-edge, is black, with bright sky-blue spots. Those little oblong spots on the black ground are light as you look directly down on them,

*I have noticed exactly the same thing in *Polygonia faunus* and in a European species of *Brenthis*, as well as in *Polygonia progne*,

but from one side they change through violet to a crystalline rose purple. . . . The broad buff-edge of the *Vanessa antiopa*'s wings harmonizes with the russet ground it flutters over, and as it stands concealed in the winter, with its wings folded above its back, in a cleft in the rocks, the gray-brown underside of its wings prevents its being distinguished from the rocks themselves. (THOREAU, *Early Spring in Mass.*, p. 252.)

Late in September, 1869, Mr. P. S. Sprague found a broken chrysalis of this species which seems to have had a curious history. The chrysalis was found suspended beneath a fence, its anterior extremity squarely docked; the aperture thus formed was filled with clay; this was afterwards broken and a ichneumonideous grub disclosed, together with four or five benumbed tenthredinidous larvae; the grub subsequently spun a silk partition to conceal itself. Unquestionably the larva of *antiopa* had been stung by *Hoplismenus morulus*, which in emerging from the chrysalis had girdled the anterior extremity after its fashion and made its escape. A roving wasp discovered the empty chrysalis case and concluded to adopt it as a home for one of its young, provisioning it with false caterpillars. Mr. E. T. Cresson has kindly determined the wasp, which subsequently made its appearance, to be a variety of *Odynerus albophaleratus* Sauss. with immaculate scutellum.

The name "Mourning cloak," now largely in use in America, is undoubtedly due to the German influence in our country, being a direct translation of *Trauermantel*; as it seems to be gaining in favor over the strictly English, and here meaningless, name of *Camberwell Beauty*, more commonly applied to it in Canada, I have chosen to adopt it.

Enemies. This long-spined, red-spotted caterpillar has plenty of foes. Five Hymenoptera are known to attack it in this country, and three in Europe, including one of those found also in this country. First, *Ichneumon fossorius* is said by Ratzeburg to destroy it in Europe. Next, a European species of *Hoplismenus*, *H. terrificus*, is said by Giraud and Laboulbène to have been bred from it. Another species of the same genus, *H. morulus* (88:9), decapitates the chrysalis on this side of the Atlantic. Then we have two species of *Pteromalus* which attack it. *P. vanessae* (89:3) and *P. puparum* (89:1-2), the latter found also in Europe, and the former also attacking other butterfly caterpillars. Dr. Harris reared *P. vanessae* on August 5; and it is perhaps of this species that Harriet Keyes writes (*Can. ent.*, xv:237), that she "counted one hundred and forty-five little green flies" emerge from one chrysalis of *antiopa*. Dr. Harris also obtained from this butterfly a *Derostenus*, *D. antiopae* (89:7) on September 15. And lastly Mr. C. W. Woodworth caught *Telenomus graptae* (89:9) at the White Mountains, in the very act of ovipositing on the eggs.

But it is also attacked by dipterous parasites. *Phorocera concinnata* attacks it in Europe, and in this country *P. edwardsii* (89:12, 25) is its

deadly foe. This insect was first made known to me by Mr. W. Saunders, who sent me from Ontario three caterpillars of *V. antiopa*, each of which proved to have been stung by it, for on arrival the caterpillars were dead and three tachinid pupae lay at the bottom of the box. It is then probable that in this case the female *Phorocera* laid but a single egg in each caterpillar, and as it effected its death, we can readily imagine, knowing how prolific flies are, what a devastation of *antiopas* this insect may create. The larvae emerged from the caterpillars of *antiopa* between July 3 and 10, and broke the pupa shell on May 4 of the following year. It therefore hibernates in the pupa state. But this parasitic fly probably sometimes lays more than one egg in a caterpillar, or a caterpillar may be attacked by more than one fly; for, judging from specimens and notes in Dr. Harris's collection, he obtained two flies from a single chrysalis; and Mr. J. Pettit of Grimsby, as I learn from Dr. Packard, found three dipterous larvae (of some kind) in a chrysalis, "which they had eaten to the shell."

These are all the parasites as yet known; but Gentry relates, in a passage already referred to, how a score of the carabide beetle, *Calosoma scrutator*, discovering an abundance of these "harmless though terrible looking caterpillars" "were waging a desperate encounter with them," causing "destruction on a singularly grand scale." And Abbot records that in Georgia "the large red wasps are great enemies to this species, seizing on a caterpillar and cutting it to pieces to make into a lump the better to carry it to their nest to feed their young with."

Desiderata. With regard to the different broods of this insect we need much more definite information over a wide extent of country before we can determine the limits within which it is single, double, or triple brooded; probably these variations in its annual history will be found to correspond to the Canadian, Alleghanian, and Carolinian faunas, so that observations should be principally directed toward the boundaries of these districts. In the Canadian fauna particular attention should be paid to the hibernation of the insect, for it is not impossible that the August brood of butterflies may lay eggs and die the same season, while their progeny pass the winter as chrysalids and so produce an early crop of butterflies; thus making the species double-brooded, as farther south, but by a different process. The same question of hibernation in the Alleghanian fauna needs careful examination, as will be seen from the preceding observations. It is quite possible that the habit of wintering as chrysalids may obtain in one place and not in another. Investigations upon the sounds produced by our butterflies can best be undertaken upon this species.

LIST OF ILLUSTRATIONS.—EUVANESSA ANTIOPA.

General.

- Pl. 20, fig. 5. Distribution in North America.
 88: 9. *Hoplismenus morulus*, a parasite.
 89: 1, 2. *Pteromalus puparum*, a parasite.
 3. *Pteromalus vanessae*, a parasite.
 7. *Derostenus antiopae*, a parasite.
 12, 25. *Phorocera edwardsii*, a parasite.

Egg.

- Pl. 64, fig. 26. Colored.
 33. Cluster, plain.
 63. Embryological development.
 67: 3, 6. Micropyle.

Caterpillar.

- Pl. 70, fig. 12. Caterpillar at birth.
 74: 28. Mature.
 78: 50, 51. Front view of head in stages i, v.
 81: 1. Web.
 86: 83. Dermal appendage, fourth stage.
 84. The same of full grown caterpillar.

- 87: 13. Leg of third thoracic joint.
 21. Proleg and hooklets.

Chrysalis.

- Pl. 83: fig. 51. Side view.
 58. Side view in outline.
 59. Dorsal view in outline.

Imago.

- Pl. 2, fig. 4. Colored, both surfaces.
 11: 2. Both surfaces, plain.
 33: 27. Male abdominal appendages; inside view.
 28. The same, outside view.
 38: 15. Neurulation.
 53: 4. Side view of head and appendages enlarged, with details of the structure of the legs.
 61: 34. Papilla of tongue.
 55. Tongue with papillae.

AGLAIS DALMAN.

TORTOISE-SHELLS.

Aglais Dalman., Vetensk. acad. handl., xxxvii: Vanessa (pars) Auct.
 56, 64 (1816).

Type.—*Pap. urticae* Linn.

The gold barr'd butterflies to and fro
 And over the waterside wander'd and wove
 As heedless and idle as clouds that rove
 And drift by the peaks of perpetual snow.

JOAQUIN MILLER.

Imago (53: 1). Head moderately large, rather densely clothed with long and short erect hairs. Front very moderately swollen, scarcely fuller beneath, as broad as high, scarcely as broad as the eyes; upper edge rather broadly rounded and protuberant in the middle, where it falls rather abruptly, and nearly as much as at the sides; lower edge well rounded. Vertex rather small, partly tumid, but posteriorly projecting beyond the height of the eyes only a very little, broadly rounded behind, in front advancing with curved sides deeply and sharply into the space between the antennae, where it is greatly sunken and connected with the front by a narrow bridge. Eyes not very large, pretty full, sparsely pilose with long hairs, longest in front in the middle of the upper half. Antennae inserted deeply in the middle of the summit in nearly connected pits, their interior bases separated by the width of the antennal stalk, and on their exterior bases closely crowded to the margin of the eyes; nearly half as long again as the abdomen, consisting of from thirty-five to thirty-six joints, the last nine or ten of which expand gradually into an oblong-ovate, depressed club, about four times as broad as the stalk, four times as long as broad, the extremity broadly rounded, three joints entering into the diminution of size, but the last disturbing the uniformity by being very bluntly conical, depressed; club furnished along the under portion of the inner side with a slight triple carina, which continues indistinctly along the greater portion of the stalk. Palpi stout, scarcely three times as long as the eye, compressed, curved slightly, the terminal joint one-third the length of the penultimate, the whole furnished with fine longer, and coarse shorter hairs, most conspicuous on the penultimate joint, and restricted generally, and especially above, to a vertical plane, adding to its compressed appearance.

Prothoracic lobes moderately large, scarcely arched, not very tumid, the anterior border straight, the posterior and superior slightly curved, well rounded and tapering nearly equally at either end, about five times as broad as long and slightly higher than broad. Patagia about twice as long as broad, very slightly tumid, very broad, well rounded and nearly circular at base, the posterior lobe projecting as a straight, narrow, greatly tapering blade, the tip curved slightly downward and bluntly pointed.

Fore wings (38: 13) rather more than half as long again as broad, the costal margin bent roundly just beyond the base, beyond it straight nearly to the tip, which is curved downward a little; outer margin slightly crenulate, the upper portion, above the middle of the lower subcostal interspace, a very little concave and having a general direction at a little less than a right angle with the middle of the costal margin; behind this suddenly receding to the middle of the succeeding interspace, and then passing in a slight, broad, concave swell to just below the lower median nervule, where it is again slightly angulated; the inner border is straight, the angle broadly rounded. First superior branch of the subcostal nervure emitted a little beyond the middle of the outer half of the upper margin of the cell; second half way between the base of the first and the tip of the cell; both a little further from the base in the male than in the female; third rather less than one-third, fourth a little more than one-half the distance from the tip of the cell to the apex of the wing; second inferior branch of the subcostal nervure arising from one-fourth to one-third way down the cell; the latter considerably less than half as long as the wing, and less than three times as long as broad; the distance from the origin of the second median nervule to the vein closing the cell is one-half that between the bases of the first and second nervules. Hind wings with the costal border scarcely convex, the outer border delicately crenulate, rather broadly curved, protuberant as a slight angular dentation at the tip of the upper median nervule; the inner border scarcely convex for nearly two-thirds its distance beyond the basal expansion, then, roundly excised for a short distance, it continues its direction nearly parallel to the former portion, the outer angle abrupt but rounded. Precostal nervure directed straight upward, not inclined in either direction, originating considerably beyond the divarication of the subcostal from the costal nervure. Cell closed by a feeble vein.

Fore legs small, cylindrical, a little depressed, clothed with a depressed, bushy bunch of long spreading hairs, rather heavier in the male than in the female; the tibia about half the length of the hind tibia; tarsi scarcely shorter than the tibia, in the male consisting of a single joint, with exceedingly slight indications of any divisions and wholly unarmed; in the female distinctly composed of five joints, of which the first is twice as long as all the others united, and these successively shorter, each armed beneath at its tip with a pair of minute slender spines. Middle and hind tibiae of equal length, furnished on either side beneath and on the upper portion of the inner side with a row of infrequent, long and pretty slender, slightly spreading spines, the terminal ones of the inferior rows prolonged to long and very slender spurs; tarsi having the first joint nearly as long as the others taken together, the second, third and fourth successively decreasing in size, the fourth half as long as, and the fifth a little longer than, the second; joints furnished beneath with four, the last with only two, rows of small and slender spines, the terminal ones on each joint scarcely longer than the others. Claws delicate, not very long, tapering to a fine point, pretty strongly curved. Paronychia slender, tapering, nearly as long as the claws, curving less and nearly straight on the apical half. Pulvillus wanting. Last joint of tarsi furnished above at the tip with four very minute and slender, but pretty long, slightly diverging, aciculate spines, directed between the claws.

Appendages of the male abdomen: upper organ small but very broad, and very broadly rounded, both transversely and longitudinally, the hook as long as the body, rapidly narrowing on the basal half, beyond nearly equal. Clasps of moderate size, bullate, twice as long as broad, nearly equal on the basal three-fourths, beyond tapering rapidly to a point, the upper basal process parallel to the clasp, but incurved more than it, large, expanded at base, tapering beyond to a point; interior finger pretty large and long, tapering, extending along the middle of the clasp and reaching to its tip.

Egg. Broad ovate, of about equal height and width, broadly rounded beneath, still more so above, narrowing slightly in passing upward, but apparently of equal width from the constantly increasing breadth of the ribs in passing from the base to the summit; these are few in number, well arched at the summit, after the style of *Vauessea*, but are not so high; they are strongly compressed and prominent; cross ribs slight but distinct, especially above, leaving between them spaces about four times as long as broad in the middle of the egg.

Caterpillar at birth. Head smooth and well rounded, broadest in the middle of the upper half where it is very inconspicuously angulate, a little broader than high, slightly sulcate above, and furnished with a few scattered hairs. Body uniform, tapering only on the last two or three segments, armed with longitudinal rows of hairs like those of *Euvanessa* but somewhat shorter and arranged in similar rows, excepting that those of the subdorsal series are more anteriorly placed, those of the supralateral decidedly posterior, and the infrastigmatal distinctly in advance of the spiracles.

Mature caterpillar. Head not very large, pretty well rounded, the sides broadly rounded, broadest in the middle; the summit of either half pretty broadly rounded, very slightly elevated, the suture between a very little depressed; the whole front is subappressed, hardly deeper below than above, covered with pretty frequent, small and minute, short conical tubercles, all the latter, and some of the former emitting pretty long hairs; triangle fully half as high again as broad, extending fully half way to the summit. Antennae with the second joint not half so long as broad, the third three-quarters the diameter of the second and half as long again as broad, cylindrical, squarely docked, emitting a moderately long hair; fourth joint not noticeable. Ocelli as in *Euvanessa*. Labrum small, half as broad again as long, well rounded, pretty deeply excised in the middle. Mandibles very small, moderately stout, the edge straight, coarsely and slightly denticulate. Maxillary palpi small; first and second joints of nearly equal diameter; third slightly smaller, fully half as long again as broad, rounded at apex; fourth minute, knob-like. Spinneret rather long, slender, curved, tapering.

Body cylindrical, largest in the middle of the abdomen, tapering more anteriorly than posteriorly, armed with pretty long, moderately stout spines, each one tapering regularly, docked at the tip, and bearing a bristle-like thorn, scarcely smaller than a continuation of the spine would have been, finely pointed and about one-third the length of the spine itself; these spines bear numerous larger and smaller cylindrical tubercles, from the larger of which, generally three or four in number, arise long acicular thorns, longer than the apical thorn of the spine, and divergent at an angle from the spine: from the smaller ones, which are much more numerous, shorter and much more delicate needles take their rise. The spines are arranged in longitudinal rows, one to a segment in each row, as follows: a dorsal series, inserted anteriorly on the second to the eighth abdominal segments; a laterodorsal series, placed a little in advance of the middle, directly over the spiracles, on the first to the eighth abdominal segments; a supralateral series, placed centrally on the second and third thoracic segments; the spines of the last two series are slightly longer than the others; a laterostigmatal series, placed similarly to the row above, on all the abdominal segments; a suprastigmatal series, placed centrally, on the second and third thoracic segments; and an infrastigmatal series, placed centrally, on the first to the eighth abdominal segments. The body is supplied pretty abundantly with minute conical warts, some exceedingly minute, each emitting a hair, proportioned in length to the size of the wart, the largest more than half as long as the spines, and on the posterior parts of the segments arranged in transverse rows; the smaller ones with no regularity of disposition; first segment with a transverse anterior series of the largest ones. Spiracles rather small obovate, nearly twice as broad as long. Legs and prolegs as in *Euvanessa*.

Chrysalis. Viewed from above the prothorax and head scarcely taper to the tips of the ocellar projections, which are conical, bluntly pointed and have their inner edges inclined at a right angle to each other, the space between them squarely docked; on a side view they are directed straight forward, a little protuberant at base, their lower edge considerably inclined to the under surface of the chrysalis, their upper nearly

continuous with the line of the prothorax. The mesonotum is considerably arched longitudinally, carinate slightly along the median line; on the anterior half just beyond the middle, elevated to an anteriorly compressed, triquetral, pyramidal tubercle, not very large, not so high as long, scarcely pointed. Inferior surface, including the appendages, straight from the base of the ocellar prominences to near the tips of the wings. Meso- and metanotum furnished with a median supralateral pair of rather small, rounded, elevated warts, higher than broad; wing tubercles of a similar form, with a short ridge running from its base toward, and away from, the supralateral tubercles of the mesonotum, and a larger one, connecting it with the supernumerary wing tubercles; the latter is little more than an elevation of this ridge to the height of the basal wing tubercle, from which it is separated by an angular, but not deep excision. Wings protuberant in the middle of the upper half of the posterior border, but not elevated to a tubercle. Abdomen less arched than in *Polygonia*, furnished with a dorsal series of small, low, inconspicuous warts on the anterior edge of the second to the eighth segments; a laterodorsal series of bluntly conical tubercles on the middle of the first to the eighth segments, similar to those on the sides of the thoracic segments, but somewhat larger, especially on the fourth segment, and excepting on the first and eighth where they are smaller; a suprastigmatal series of low, inconspicuous warts a little in advance of the middle of the third to the seventh segments; and an infrastigmatal series of similar warts on the middle of the fifth to the eighth segments. Preanal button similar to that of *Euvanessa*, the bounding ridges very heavy. Cre-master, viewed from above, nearly half as long again as broad, scarcely tapering, the bounding walls low, broad, equal; viewed from the side slightly tapering, considerably enlarged at the tip. Hooklets rather short, not much enlarged at the tip, which is bent roundly at right angles, and has a sharply produced, short, downward directed apex.

This group is represented by two species of moderate size; one, *milberti*, is found in North America north of the 42d parallel; the other, *urticae*, spreads over the whole of Europe and northwestern Asia, that is, the western two-thirds of the Old World, north of the 36th parallel, and is found alike on plains and mountains, to the height of 8,000 feet. The American species is found throughout New England, but is very rare in the southern portions.

The two species differ considerably, the European insect greatly resembling the species of *Eugonia* on its upper surface, except in having the basal half of the hind wings wholly dark, and thus leaving a broad, tawny belt between it and the outer border; while the American form has most of the base of the fore wings similarly obscured, so that the colored belt is common to both wings. The under surface is dusky, the basal darker than the outer half, the whole traversed by short, delicate, transverse, darker threads, and the outer margin obscurely marked with greenish or bluish atoms on a dark ground. The changes undergone by the European species in its longitudinal range in their direct relation to temperature have been discussed by Reichenau (*Kosmos*, xii: 46-49).

There are three broods of these insects in the most favorable localities, although Meyer Dür says there is but one of *urticae* in the high Alps. The butterflies hibernate and also some chrysalids. Dr. Meyer Dür writes that he has often carried chrysalids of the European species through the winter, which invariably disclosed *females* in April. The first brood ap-

pears about the middle of June, the second in the latter part of July, and the third early in September; and since hibernating butterflies continue on the wing late in the spring, the imago may be found at almost every season.

The butterflies have an active flight, and are found by roadsides and in gardens, fields and sunny open spots in wooded districts. The caterpillars subsist on nettles, and are rapid growers; the chrysalis state averages from ten to fourteen days in duration.

The eggs are laid in clusters upon the under surface of leaves, usually near the top of the plant, and are cylindrical in shape, scarcely taller than broad, and furnished with eight to ten prominent, compressed ribs. The young caterpillar closely resembles that of *Euvanessa*, but has somewhat shorter hairs with a slight difference in their arrangement. The head of the mature caterpillar is regular, and covered with bristly hairs, starting from short tubercles, and the body bears on either side two rows of long, tapering, thorny spines, and also, behind the first abdominal segment, a dorsal series of similar appendages. During early life — the first two or three stages — the caterpillars are sociable, living together under a common web; subsequently they disperse indiscriminately over the plant. The chrysalids are very similar in general appearance to those of *Euvanessa*, but all the protuberances, especially the dorsal projection of the mesothorax, are much less prominent. They hang a variable length of time, from four to eighteen days, those of the European apparently longer than those of the American species.

By way of comparison with the habits of our own species, I may here give a brief account of my observations on the European urticae. The eggs are laid in rude clusters on the under side of leaves of nettles, about the middle of the leaf, the uppermost leaves being usually selected; but I found one patch on a leaf about half way up the stalk, and the little caterpillars (all of which had not then hatched) had formed a nest at the base of the leaf. When very young, and apparently until their second moult, these caterpillars live within nests formed by clustering the terminal half-opened leaves of the nettle into a globular mass, liberally covered with web; after that the colony divides, some going in one direction some in another, but keeping company in flocks, which wander from the summit of one plant to a neighboring one, and leave the marks of their progress in the blanched films of the upper leaves, all besmeared with web; they seem to prefer the upper leaves of a plant, and thus they sometimes swarm over the whole surface of an extensive bed of nettles in full view, huddling in clusters of individuals, which are constantly creeping and re-creeping over each other; when they wish to moult they seek, sometimes singly, sometimes in companies of as many as three or four, leaves growing lower on the stem, or which at any rate have been but little, or not at all eaten, and fold the leaf together much after the manner of *V. atalanta*; the

opening toward the apex of the leaf is closed by a delicate film of silk, attached at half a dozen points to the leaf, and thickest in the middle; those which contain more than one usually have the film denser, as if all had partaken of the work; in this position one might easily think one had found the larva of *V. atalanta*, especially should a portion of the tip of the leaf be devoured; but the leaf is never pendant, as when the nest conceals *atalanta*, and the gate to keep out intruders is also wanting in the latter; the object of such a performance, at the critical moment of moulting, on the part of a caterpillar which at other times lives in such disgusting familiarity with the other members of the family, is apparent.

A worn specimen of the European species, *A. urticae*, was taken on the wing in June, 1873, at Watertown, Mass., by Mr. Outram Bangs, who has shown me the specimen. It was also reported to have been taken in *Mexico* (*Entom.*, xx: 333), but Mr. Druce, the exhibitor, writes me that it was an unfortunate typographical error for *Moscow*!

EXCURSUS XII.—HOW BUTTERFLIES WINTER.

No butterfly flits through November's gloom,
No bird note quivers on its frosty air.

LOUISE CHANDLER MOULTON.—*Automne*.

ONE would suppose that nature would have so arranged matters that delicate creatures like butterflies, passing a portion of their lives in a quiescent condition, would select the winter as the season in which to pass this state, and not waste the precious moments of a too brief summer, when flowers and succulent plants are abundant as food for butterfly or caterpillar, in an enforced inactivity. Yet a very considerable proportion of the butterflies of New England pass the winter in some other state than that of the chrysalis. Some pass it in either of two or more states, apparently as a precaution against the total destruction of the species. Many pass the winter as caterpillars, some as eggs, and not a few as butterflies themselves. Many of the *Theclidi* for instance pass the winter in the egg state,* while on the other hand the *Vanessidi*, a group which, whether in Europe or America, may be considered as almost characteristically pertaining to the temperate zone, where the winter is pronounced, pass the winter in the imago state. One reason for this is that there is nearly always an autumn brood of butterflies which disport themselves in

* The Rev. Mr. Hellins of England found *Rusticus aegon* and *Erynnis comma* passing the winter in the egg state, and von Prittwitz claims the same for several species of *Theclidi* and *Coenonympha pamphilus*,—besides two others, subsequent observations on which have proved his conjectures about them to be

erroneous. In New England we know that several of the *Theclidi* (*Thecla liparops* and *Strymon titus* certainly) and some of the *Chrysophanidi* winter in this condition, and it is not improbable that it may be occasionally the case in some of the *Argynnidi*. *Parnassius*, an alpine genus, winters in this way.

great numbers in the latter part of the year, but have not time to undergo further transformations so as again to reach the chrysalis stage before winter would cut them off; but in some instances some of the chrysalids which should produce the autumn brood do not give out the butterfly until the following spring. According to Wiesenhütter such chrysalids of *Eu Vanessa antiopa* as pass the winter are presumably females, inasmuch as the female, according to his observation, is generally fresh colored in the spring, whereas the males are always very much battered and worn. So far as we know, in the case of these wintering butterflies, pairing always takes place in the spring. (See the observations of Schilde, Wiesenhütter, and Goossens on *Eu Vanessa antiopa* and *Inachis io*.)

Those hearing for the first time of the existence of butterflies in winter, invariably inquire where the butterflies may pass the winter period. Each species has its own peculiar hiding places, but in general they may be found beneath piles of rocks, in hollow places in the trunks of trees, especially near the roots, beneath the rafters of old buildings, in corded wood in the forest, and even in some instances probably simply hanging beneath the branches of trees. Thus Landois saw the European *Inachis io* take up its winter quarters in an ivy, hanging from a branch by its hind legs, folding all its other legs on its breast and closing its wings. During a warm spell in the early spring it disappeared, only, when the weather again changed, to return to the same spot and reassume its former position. Woodmen sometimes, in cleaving open a tree, will discover a little colony of hibernating butterflies, as has been done in the case of *Anosia plexippus*; and Goossens of Paris, in beating small trees over his open umbrella (a favorite mode of collecting) in the cold days of November, twice brought down *Polygonia c-album*, which fell upon its feet with closed wings. It would seem that they must therefore have chosen the under side of the branches for hibernation. He made some interesting observations upon these, bringing them home and placing one in an unwarmed apartment, the other in the open air on the north-east side of a window. They did not stir until February, when they resumed their activity. The one in the open air had experienced a temperature of at least $-5^{\circ}\text{C}.$, and Goossens discovered that numbness only comes on at $-2^{\circ}\text{C}.$, for when it was warmer their position showed that they appreciated the difference between day and night. At such a time the hind wings are kept motionless, but in the day time the fore wings are advanced, so that the inner margin is at right angles to the body; at dusk, the fore wings creep backward and finally pass partly behind the hind wings, nearly filling the empty space between the two wings in this genus, due to their great excision. The process is again reversed in the morning, showing that the butterflies are not completely benumbed and, however quiet, recognize the distinction between night and day. (Bull. Soc. ent. Fr., 1887, 29.)

All hibernating butterflies, so far as known at present, belong to the Nymphalidae and Papilionidae, and almost exclusively to the Vanessidi and Rhodoceridi, neither Lycaenidae nor Hesperidae being known to hibernate in the perfect stage. Almost all the Vanessidi of Europe as well as *Colias rhamni* are known to hibernate in the imago state, and in our own country *Anosia plexippus*, all the Polygonias, *Eugonia j-album*, *Euwanessa antiopa*, *Aglais milberti*, all the species of *Vanessa* and *Junonia coenia*, as well as *Hypatus bachmanii*, and among the Rhodoceridi, *Callidryas eubule* and *Xanthidia nicippe*.

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No special paper has been written on this subject in this country, but for the European butterflies, see Zeller's List of the Lepidoptera of the Oder wintering over in the perfect stage (Stett. ent. zeit., xiv: 49); von Prittwitz's List of butterflies of Silesia and the condition in which they pass the winter (Ibid., xxii: 191); and Hellin's List of British Macrolepidoptera which hibernate in the egg state (Ent. monthl. mag., March, 1870).

AGLAIS MILBERTI.—The American tortoise-shell.

[The forked butterfly (Gosse); Milbert's butterfly (Harris); the nettle tortoise-shell (Scudder); the red empress (Ross).]

Vanessa milberti God., Encycl. méth., ix: 293, 307-308 (1819);—Boisd.-LeC., Léop. Amér. sept., 187, pl. 50, figs. 3-4 (1833);—Doubl.-Hewits., Gen. diurn. Lep., i: 201. pl. 26. fig. 4 (1849);—Harr., Ins. inj. veg., 3d ed., 302-303, fig. 125 (1862);—Morr., Syn. Lep. N. Amer., 56 (1862);—H. Edw., Pac. coast Lep., ii: 10 (1873);—Coq., Rep. ins. Ill., x: 164-165 (1881);—Fern., Butt. Maine, 58-59 (1884);—Edw., Can. ent., xvii: 181-188 (1885);—French, Butt. east. U. S., 195-196 (1886);—Mayn., Butt. N. E., 17-18, pl. 1, figs. 19, 19a (1886).

Nymphalis milberti Kirb., Syn. catal. Lep., 648 (1871).

Aglais milbertii Scudd., Syst. rev. Amer.

butt., 21 (1872);—Butt., 137-138, figs. 82, 127 (1881).

Grapta milberti Middl., Rep. ins. Ill., x: 85 (1881).

Vanessa fuscillata Say, Amer. entom., ii, pl. 27 (1825?); Entom. N. Amer., ed. LeC., i: 62-63, pl. 27 (1859);—Kirb., Faun. bor.-amer., iv: 292-293 (1837).

Vanessa urticae Emm., Agric. N. York, v: 209; the figure is that of the European species (1834).

Figured by Glover, Ill. N. A. Lep., pl. 37, fig. 3, ined.

[Not *Pap. urticae* Linn.].

Bright, bright, restless bright, through the sunburnt meads,
Wavers the butterfly;
Ever across its path a pilot invisible leads
A sylphid fleet of the thistle's light and feathery seeds,—
And August passeth by.

EDITH THOMAS.—August.

Imago (2:7; 12:10). Head covered thickly with long, fine, mouse-brown and pale brown hairs, with intermingled, very long, scarcely coarser, blackish ones; a few pale, gray brown scales skirt the hinder part of the eye. Palpi covered with blackish brown scales, and a superior and inferior fringe of very long, stiff, black hairs, the basal and middle joint edged externally above and below with a dull, pale, slate brown row of scales, becoming fainter toward the apex of the middle joint, where the darker scales become decidedly black; last joint wholly black; the inferior fringe of black hairs is flanked interiorly with a series of equally long, pale, gray scales. Antennae blackish, the basal half of the joints streaked with whitish on the upper portion of their inner

surfaces; towards the base of the antenna a few white scales are also scattered about above; beneath, the basal joints—about ten of them—are blackish, broadly annulated basally with sordid white; beyond naked, dark castaneous; club like the stalk, but touched with white only on the basal fourth, and the apical four joints luteous. Tongue castaneous, deeply infuscated, almost black laterally, especially beyond the base.

Thorax and patagia covered above with long, dark brown hairs tinged with fulvo-olivaceous, below with pretty long, grayish brown hairs; fore legs blackish brown down the front, with the expanding fringe of the same gray as the under surface of thorax; other legs dark purplish brown with a few intermingled very pale brown scales, more abundant on the hind than on the middle pair and much more profuse on the tarsi than on the tibiae, scarcely present on the femora; the inner, and to a slight degree the upper, surface of the femora enlivened by yellowish scales, which also tip the whole femora, and tinge some of the lateral pale scales of the tibiae; spurs reddish castaneous; spines of tibiae golden yellow; of tarsi blackish or very dark reddish; claws castaneous, the basal half inclining to pallid, the apical to fuliginous; paronychiae castaneous.

Wings above black, with a maroon tinge, and orange fulvous markings. *Fore wings* with the basal half of the costal border transversely and obscurely barred with rather pale brown and flecked, not profusely, with flavo-luteous scales, growing darker and more reddish as they approach the base; the base of the wings beneath the costal nervure and as far outward as the first divarication of the median flecked considerably with reddish orange scales, which, at their exterior limit in the cell, are collected in a distinct spot traversing the whole cell and slightly paler or brighter in the centre; a similar but better defined spot occupies the exterior limit of the cell, but fails of reaching the median nervure excepting at its interior limit, which is slightly sinuous and advances a very little toward the base in approaching the median nervure; its exterior limit is curved, its convexity outward, and the spot which is broader than long is orange fulvous; it is indistinctly surmounted above by a slight, pallid spot above the costal nervure; the outer half of the wing is crossed by a very broad belt of orange fulvous, somewhat and rather abruptly paler along its interior limit, more broadly below than above; the interior border of the band extends from the inner margin to the middle of the wing in a band of equal width; above that it broadens, and when it has reached the next to the lower subcostal nervule divides into two slender stripes, the interior of which is pale yellow and reaches, while the other is whitish and just fails of reaching, the costal border, and which enclose between them a subquadrate spot, rounded beneath and projecting a little outwardly; this spot depends from the costal margin and extends, longitudinally, from the origin, or just beyond the origin, of the third to a little beyond the origin of the fourth superior subcostal nervule; the interior margin of the broad band is minutely subcrenulate and extends in a general broad curve from the costal border just within the origin of the third superior subcostal nervule, crossing the middle median nervule at an interspace's distance from its origin, to the inner border in the middle of its outer two-thirds; the exterior border of the band is sinuous, subparallel to the outer margin, placed above midway between the outer margin of the inner upper branch of the broad band and the apex of the wing; and below fully three-fifths the distance from the interior border of the broad band and the outer margin of the wing. The outer margin for the distance of half an interspace is of a pale, ashy brown with a median stripe, sometimes nearly supplanting it, of dark or blackish brown. Fringe black, tipped, especially in the interspaces, with dark, ashy brown. *Hind wings* with the cell and all below it and as far outward as the limit of the black portion heavily clothed with long, brownish, dull fulvous hairs more or less obscuring the black base (and more frequent in the ♂ than in the ♀?). Across the outer half of the wing is a broad belt, continuous with that of the fore wing and similar to it in width and color, except that the paler, yellowish portion is much broader above than below (and less extensive in the ♀ than in the ♂?); its interior margin extends from the costal border at the middle of its outer two-thirds, in a nearly straight but

slightly sinuous course, across the upper median nervule just within the limit of its basal curve, to the inner border at its excision; its exterior margin is pretty regularly bowed, approaching the outer border at either end, and on the upper median nervure lying scarcely more than midway from the interior border of the belt to the tip of the dentation; outer margin of the wing ornamented precisely as in the fore wings, excepting that within it, small caerulean lunules are seated in the interspaces upon the grayish stripe, their exterior margins straight, their interior curved, excepting in the medio-submedian interspace, where they are transversely linear, always widely separated from each other; occasionally they are very minute. Fringe as in fore wings.

Beneath, dark bluish, slate brown, the fore wings generally a little duller than the hind wings, the limits of the belt much as above but only distinct next the inner border. *Fore wings* with the costal border streaked with transverse black bars which do not reach the nervure excepting next the base; the cell is crossed by two zigzag, transverse, black lines, one uniting the first branches of the subcostal and median nervures, the other parallel to it a short distance within; further toward the base there is an oblique, longitudinal, oval, black loop seated on the median nervure close to the base and projecting into the cell; and the apical portion of the cell, which is grayer than the rest of the base, is traversed by many inconspicuous curved threads of blackish scales; the interior margin of the extra-mesial belt is limited also by a black line over portions of its course, especially above and below and there are other short, black streaks next the upper outer margin of the cell; the portion occupied above by the belt is grayish, made up of a mixture of brownish scales of various shades from pallid to ferruginous, but is coursed throughout by transverse, blackish and dusky threads; the spot depending from the costal border is very inconspicuous and the outer border of the belt very obscure, but very frequently there is a slender, brownish fuliginous streak running from its upper outer limit to the centre of the belt and then continuing down its middle; the outer margin is similar to the upper but darker and enlivened at the same time with lilaceous scales, and the slender, blackish stripe which borders it interiorly is nearly hidden by a series of continuous, slender, scarcely curving, pale caerulean lunules. the fringe is cupreous blue, tipped in the interspaces with whitish. *Hind wings* with the belt better marked, its inner border conspicuous by the distinct black edging throughout its course; within this there is a second broken, equally slender, transverse, black stripe; it crosses the costo-subcostal interspace diagonally, midway between the base and the outer black stripe, touching the subcostal just within its first divarication; it crosses the cell in a slight outward curve, connecting the bases of the first branches of the subcostal and median, and the medio-submedian interspace a little within the first divarication of the median; within this series of transverse stripes the wing is dark grayish brown, with basal and subbasal patches of bluish slate brown, and traversed by numerous, short, transverse threads of blackish; the belt is much as in the fore wings, but is more uniform and shows darker brown, faint spots forming an obscure transverse series in the middle of the outer two-thirds. Fringe as in fore wings.

Abdomen above black, covered next the base with brownish hairs; beneath, slate gray, darker toward the base; appendages of male (33: 25, 26): upper organ; body almost twice as broad as long; hook nearly straight, compressed, rapidly tapering, with straight sides on basal half, slightly depressed on apical half so as to be a little ovate from a superior view, bluntly pointed. Clasps fully twice as long as broad, of equal breadth on the basal half; beyond tapering a little and on the apical fourth rapidly, the upper hinder angle very slightly produced and incurved; upper basal appendages compressed, nearly five times as long as the breadth of base, narrowing very slightly just beyond the base and then suddenly expanding at the upper edge to twice the height, forming a rounded lobe, more abrupt posteriorly than anteriorly, as high as broad, inclined a little backward; beyond this it tapers to a point and curves pretty strongly inwards, having previously had only a backward direction; interior needle pretty broad, on basal half compressed; beyond tapering to a point, a little arched and reaching close to the tip of the clasp.

Measurements in millimetres. Length of tongue, 10.25.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	20.5	22.5	25.		25	
antennae.....	10.75	11.75	13.			
hind tibiae and tarsi.....	7.	7.5	8.1		8.	
fore tibiae and tarsi.....	2.75	3.5	4.25		3.5	

Described from 6 ♂ 1 ♀.

Suffused variety. Gosse (Can. nat., 248) speaks of finding near Compton, Canada, a specimen of this species the wings of which agree in every respect with the normal type, except that "the first pair on the upper surface are black, with only a row of small, indistinct and undefined red spots in the place of the broad, orange band; the bright, fulvous spots on the front margin are wanting."

Egg (64:36, 40). Pale grass green; ribs nine to ten in number, all reaching from just above base to summit; surface smooth, glistening. Micropyle rosette occupying one-third the diameter of the space between the extremities of the ribs and consisting of about ten kite-shaped cells around a common centre, surrounded by one or two rows of considerably larger, angular cells, separated by pretty broad walls, the outer cells about a third or a fourth as large as all the kite-shaped cells together. Height, .65 mm.; breadth, .65 mm.

Caterpillar. *First stage.* Head (78:54) dark olivaceo-fuscous, the sutures black; mouth parts and antennae pale, edged with dusky. Body very pale, uniform, greenish yellow, almost colorless, the hairs black, on dusky warts. Length, 1.7 mm.; breadth of body, .3 mm.; of head, .42 mm.

Second stage. Head (78:55) black; mouth parts dusky with pale annulations. Body variable, some specimens being pale yellow with slight or somewhat distinct, small, lateral, triangular, longitudinal, forward pointed, dark yellowish brown spots, one on each segment in an infralateral band, the hairs pale on pale warts; others being yellowish only beneath and on the inferior half of the sides, while above they are heavily mottled with dark rufous brown, as far as and including the infralateral band of the others; within it are broad, pale, subdorsal bands separated from each other by only an interrupted dusky dorsal line; the sides are variegated more or less interruptedly with rather irregular, mottled, paler reddish brown, or brownish yellow suprastigmatal and infrastigmatal bands; hairs black on dusky warts. In both forms the legs and prolegs are dusky green at base, beyond annulate with fuscous; spiracles black. Length, 3.85 mm.; breadth of body, .5 mm.; of head, .7 mm.

Third stage. Head (78:56) black, the warts black with dark hairs; mouth parts dusky or black. Body umber brown or very dark castaneous, with narrow, wavy longitudinal stripes of pale lemon yellow, viz., a subdorsal stripe more distinct on the anterior than on the posterior half of the segments, an infrastigmatal, pretty uniform stripe, and a series of partially connected curved stripes on each segment, starting as a slender thread, from just above the infrastigmatal stripe and arching between the spiracles to the suprastigmatal line, where it is broadest, sometimes connected above the spiracles so as to make a suprastigmatal band, nearly or quite as uniform as the infrastigmatal; beneath dull greenish yellow, mottled faintly with brownish yellow, flecks mostly connected in longitudinal stripes; prolegs dull green with narrow dusky annulations; legs black; spines and hairs black; spiracles black in a yellow annulus. Length, 8 mm.; width of body, .9 mm.; of head, 1 mm.

Fourth stage. Head (78:57) shining bronze black, the warts yellowish white, with mingled white and black hairs; mouth parts dark. Body above, as far as suprastigmatal line, blackish purple, enlivened by faint, pale yellow warts, wholly absent from a dorsal stripe, the spines (86:66) shining black, and the hairs arising from the warts mingled pale and dusky, from the spines black; interrupted suprastigmatal and continuous infrastigmatal, wavy, lemon yellow stripes; beneath these dull green, heavily mottled with umber brown; prolegs like the surrounding parts, the apex dusky; legs black; spiracles black in a livid annulus. Length, 15 mm.; breadth of body, 2.35 mm.; of head, 1.5 mm.

It is first in this stage that the hinder part of the body becomes considerably larger than the front portion.

Last stage (74:36). Head pretty smooth, shining piceous, the warts white, the hairs black or white; one of these elevations, larger than the others, and seated on the summit of either half is black; basal joint of antennae pale fuscous, beyond black; ocelli black; labrum reddish black; maxillary palpi pale fuscous at base, beyond black. Body above velvety black, below greenish yellow, the limit between the two being a wavy line just below the spiracles: but above this there is a narrow yellow band formed of a series of broad crescents, each of which starts from the top of a spiracle and ends at the bottom of the next in advance; these are sometimes abbreviated into yellow spots on the anterior half of the segments; below this line, and just above the legs, there is a brownish fuscous interrupted band; there is also a broad, ventral, blackish fuscous band; warts whitish, giving rise to white, sometimes black hairs; in some specimens, especially in those which are fully grown, the warts of the upper side are of a larger size, of a brownish yellow color and so thickly clustered, in a broad dorsal band without sharply defined borders, as to give the whole dorsum enclosed between the laterodorsal spines a sort of snuff color, with a narrow, interrupted, dorsal line: spines mostly black, those of the infrastigmatal series yellow with black spinules; but in the snuff-colored specimens mentioned above they have yellow spinules and in the laterostigmatal row, both the spines and spinules are also to a greater or less degree yellow. Spiracles black, environed with yellow; legs black: the claws dark reddish; prolegs pale greenish. Length, 20 mm.; breadth of body, 4.5-5 mm.; length of longest spine, 1.75 mm.; breadth of head, 2.5 mm.

Chrysalis (83: 43, 49, 50). Either grizzly gray, from a pale brown surface pretty uniformly and profusely flecked and creased with blackish fuliginous; or pale golden green, excepting the exposed portion of the lower wings and the abdomen beyond the third segment, which are very pale salmon varied with pale green, all the creases pale ferruginous and indistinct. In the latter case the ridges and larger prominences of the anterior half of the body are more or less pallid, edged and tipped with pale testaceous and irregularly marked with black-brown, and the tongue and the incisures of the legs and antennae are infuscated. In the dark forms these are blackish or flecked more heavily than elsewhere, but the mesonotal tubercle is edged with pale castaneous. In both cases the abdomen has similar markings with dissimilar colors. The tips of the abdominal tubercles are castaneous in the dark, very pale castaneous in the light forms, in both edged beneath with black, noticeable only in the dark forms. Gosse describes the tips of these tubercles as "of the most brilliant gold, like polished metal." There is a stigmatal abdominal band, darker than the ground, made up of short, bent, oblique lines crossing the spiracles and directed from below upward and backward. The ground also, especially in the paler forms, is slightly darker in a broad field on the outer side of which the supralateral tubercles of the abdomen lie, which has a tendency to deeper tones in similar oblique markings, varying in intensity in different specimens, and leaving a narrow, paler dorsal stripe between them. There is also a distinct, broad, dark, ventral band edged with blackish on all the abdominal segments. Posterior margins of the segments pale green with nearly equidistant fuscous dots in the pale specimens, or pallid with black dots in the dark. Spiracles testaceous with a pale areola; sides of the cremaster black or with a blackish median streak, the preanal lateral ridges pallid, more or less heavily margined on both sides with black or fuscous. Length, 18.5 mm.; greatest breadth, 6.1 mm.; breadth at ocellar prominences, 3.5 mm.

Geographical distribution (20:6). This characteristic member of the Canadian fauna is found across the entire continent of North America; eastward it occurs in Nova Scotia "rare" (Jones), Cape Breton (Thaxter), Newfoundland "the most abundant of all the butterfly tribe" (Gosse), and Godbout River, southern Labrador (Corneau); westward it is found

from Vancouver Island (Fletcher) and the Gulf of Georgia (A. Agassiz, Mus. comp. zool.), to central California (Edwards, Butler) and the Sierra Nevada near Truckee (McGlashan). To the north it is reported from "arctic America—Ross," probably the region about Great Slave Lake (Brit. Mus.), Fort Simpson (White in Richardson's Journey), and Fort William (Kirby), in the region between Athabasca and Hudson Bay (Geffcken), at Moose Factory, Hudson Bay (Weir), at Chief Mountain, Montana (Cones), the Lake of the Woods (Dawson), Sault St. Marie (Bethune), and at Quebec (Bowles, Fyles). Southward it is found in considerable abundance at the upper limits of the Alleghanian fauna and has even been seen occasionally as far south as Long Island (Graef), Staten Island (Andrews) and Philadelphia (Blake, Reakirt); other southern localities west of New England are Albany and Schoharie (Lintner), West Farms (Angus), Fallsburg (Lockwood, Mus. comp. zool.), Ithaca (Parker, Mead), Fredonia (Mark) and Rochester, N. Y. (Edwards); Cleveland, "among the most rare species" (Kirtland). "seldom seen" (Kirkpatrick), and Rockport, Ohio (Kirtland); London, Ont. "usually common" (Saunders), South Michigan "rare" (Harrington), Illinois (Reakirt), Minnesota (Scudder), Rocky Mountains, Colorado (Reakirt, Mead, Snow, Putnam), Summit Co., Utah (Putnam), New Mexico (Snow) and Arizona (Morrison).

It is found almost throughout New England, but is extremely rare in the southern portions; the only instances known to me of its occurrence in Connecticut are New Haven (Smith), Norwich a single specimen (McCurdy) and Farmington (Norton). In the Cambridge Museum is a specimen taken near Taunton, Mass., by G. W. Pepper; about Boston, except occasionally, it is exceedingly rare, but is already a rather common species in Williamstown (Scudder) and some other parts of Berkshire Co., Mass. (Minot), as well as in Walpole (Smith), Dublin (Faxon), Milford (Whitney) and the Isle of Shoals, N. H. (Thaxter). Still further north it is very abundant, often the commonest species in its season, and is plentiful in the White Mountain region itself, flying to the highest summits.

Haunts. The butterfly is found most abundant by the roadside, especially among the hills and by the margin of forests; in the White Mountains it is frequently seen in company with *Polygonia faunus*; it is rather wary, easiest taken when settled with expanded wings in the road; it is always found in sunny exposures, is fond of resting on dry leaves scattered over the ground in spring, and, like many other early butterflies, is attracted by the blossoms of the lilac.

Oviposition. At noon one June day I noticed two females endeavoring to lay eggs on a patch of nettles by the roadside at Scarborough, Me., though they were often disturbed by passers by. One alighted a great

many times and felt around with her abdomen, always on the under surface of the leaves, but apparently without satisfaction. Finally she stopped longer than usual on a leaf second or third from the top, about two inches long, which had its edges still together, and after she had left I found two large, partially superposed bunches of eggs, 400-500 in all, which she had not had time to lay, so that other females had found this same leaf attractive. Search for eggs at different times with easy success showed that leaves are generally chosen rather above the middle of the upper half of the plant, but not at the extreme summit. The eggs are usually laid with no regularity, in confused heaps, of about three or four layers, and an enormous number must be laid by single individuals. I counted 79 in one patch (11.5 mm. long and 1.75 mm. broad), 713 in another (18.5 mm. long and 9.5 mm. broad), and estimated that a third, which was about 20 mm. long and 4 mm. broad had about 500, while a fourth 28 mm. long and 6 mm. broad must have contained 900 (64:40). Several times I have found two or more patches on the same leaf. Sometimes, however, they are laid in a single layer spread widely over the leaf, and H. R. Gilbert once found them "loosely scattered over the upper side, covering nearly half the leaf" (Can. ent., xvii: 187). They are usually laid near the middle of the leaf, and generally on one side only of the midrib. Even when heaped, the eggs usually have a general upright position, especially those next the leaf, but in reality take a good many directions; adjacent ones, however, lie much in the same way, and some of those on top may lie upon their sides. The eggs hatch in about six days. The eggs are very tough and elastic, and adhere strongly to one another, so that they are difficult to separate.

Food plants. The caterpillars of this butterfly feed upon the common nettle, *Urtica dioica* L., and doubtless also upon other species, though they cannot be raised, according to Edwards and Gilbert, on the broad leaved species. They feed readily on *U. gracilis* Ait. Edwards (Hayd. Bull., iv: 516) says that Mead found them in Colorado feeding in great numbers on willow! But Mead himself in Wheeler's Report says he found them on nettle about Denver.

Habits of the caterpillar. The young creatures on escaping from the egg do not stop to devour them in the least, but after eating a portion or the whole of the leaf on which they are born, climb to the summit of the plant by weaving a silken path; within a day they smear the whole summit with a web and may be seen swarming (for they are highly gregarious in early life) upon the dried, curving projections of the leaves upon which they soon fasten themselves for a moult. They feed crowded side by side, and on the least disturbance raise their heads and front part of the body at right angles to the rest and wag them slowly in concert, producing a ludicrous effect. They are generally found on the upper surface of

the leaf and, until half grown, make no attempt whatever to conceal themselves. After the third moult, when they have attained half their size, they quit these webs and scatter over the neighboring plants, living singly or by small companies of three or four, "leaving their deserted habitations mere leafless stalks, covered with the dense and cloth-like web, and with the excrement and sloughed skins of the caterpillars" (Gosse). At this time, they occasionally collect together in larger or smaller numbers in incompletely closed leaves of nettle, but they leave the nest to feed in the most exposed manner.

These nests (81:4) are thoroughly closed next the base of the leaf, the edges having been closely drawn together with silk along the basal half of the leaf; to effect which, an irregular, triangular notch is eaten close to the base (81:3), cutting through one or both of the principal lateral ribs which spring from the very base of the leaf, leaving two considerable flaps which are fastened beneath the stem by their tips, thus bending the leaf at a strong angle between the deepest parts of the notches; the edges of the notch are then united, closing completely the pocketed base of the leaf; the opposite extremity, however, flares completely open, but by the bend in the leaf is hidden from view above. I have never found any of these leaf-nests the apical third or half of which were not eaten, so that I suspect an eaten leaf is chosen at the start. The caterpillars are sometimes so abundant in certain places that the nettles by the roadside are fairly black with them. When young they do not bear confinement well.

Life history. There are three broods annually, both the butterflies and chrysalids hibernating; the former make their appearance by the middle of March while the snow is still upon the ground; and where *E. antiopa* is found but rarely, as in Newfoundland, it is the earliest butterfly on the wing. The chrysalids disclose their butterflies sometimes early in April, and both new and old continue on the wing until nearly the end of May, at the White Mountains until June. They lay their eggs on the young nettles late in April and in May, and the caterpillars begin to change to chrysalids in the first half of June; after passing from ten to twelve days in this state, the first brood of butterflies from chrysalids of the same year makes its appearance, say about the middle of June, and becomes abundant by the 21st,—at least in the southern portions of its range. The butterflies continue on the wing until after the middle of July; the eggs are laid very soon after the eclosion of the butterfly; caterpillars may be found during July, and after the usual period in the chrysalis state, sometimes shortened to five (Fischer) or even four days (Billings), the second brood of butterflies appears; this is at the very end of July or sometimes very early in August, and the butterflies continue to emerge until at least the middle of August. These must oviposit at once, for the caterpillars are full grown at the end of August and appear as butterflies early in September before

those of the previous brood have disappeared; from which one might infer that there are only two broods, the second prolonged by the dilatoriness of some butterflies in laying their eggs; but this hardly appears to be the case. A portion of the chrysalids of the last brood remain over winter and some give birth to the butterfly as late as the first week in October. The butterfly may occasionally be found even to the middle of November. It hibernates under stones found in piles; thus Jack (*Can. ent.*, xvii: 30) found several under a stone fence "two or more almost always found under the same stone or near together," and Gosse (*Ibid.*, xv: 49) found one half torpid "on a stone in the midst of a loose heap"; but he also had one brought him from a barn-loft.

Flight and attitudes. The butterfly has a rapid, lively flight, not unlike that of the *Polygonia*e. When at rest the wings are usually either tightly closed or spread in a perfectly horizontal plane, the fore and hind wings being so placed that the colored band of the upper surface is continuous; sometimes, however, the wings are slightly raised or even a very little depressed. The body is elevated at an angle of about 20° ; the antennae are raised at an angle of about 25° with the body and spread at an angle of 90° , their tips being 15 mm. apart.

When at complete rest as if in sleep, the hind legs are thrust back and the middle pair widely spread, so that the body nearly or quite touches the ground; the wings are folded back to back, as described above, and the antennae are enclosed between them, their tips touching the costal border of the hinder pair.

Enemies. Although so numerous, comparatively few autumn caterpillars pass beyond the larval state, the larger proportion falling victims to a parasitic fly, *Apanteles atalantae*. In one instance, of twenty-five larvae which I placed in my breeding cage, only five became chrysalids. From the body of each of the others, when full grown, a number of worms emerged and spun themselves up in small, white cocoons, placed with perfect regularity side by side, forming a compact bundle, usually round in form, made up of from twenty to sixty cocoons, the whole enveloped in a cottony substance (88: 13). The cocoons are in every instance spun underneath the larva; as the mass increases, the body of the exhausted larva above it is raised up from the leaf or stem on which it rested, and embraces the bundle in its curve. The larva presents us with an instance of great tenacity of life; even when every portion of its body has been honeycombed by the escape of the large number of parasites which it had nourished—sufficient, one would suppose, to produce speedy death—"I have known its life to be prolonged for a period of seven days thereafter" (*Lintner, Proc. ent. soc. Phil.*, iii: 62). These parasites, which Mr. P. S. Sprague and afterwards Miss Soule unwittingly sent me in the body of their host from Vermont, lie in the body of the caterpillar in great numbers with their heads directed

backward. The first token one has of their presence is in seeing some pale greenish yellow worms 5 mm. long and 1 mm. broad, pushing their way through apertures they had made in the sides of their host. Their movements are very slow and their passage effected through exceedingly small openings by bloating the front part when it has emerged, and so squeezing their way out. In the instances in which I have observed it they emerged from their host late in August and through September, and the flies appeared in about ten days.

Milberti has other enemies. Gosse mentions one of the Ichneumonidae which issues from this chrysalis, which is then like polished gold in front, tinged with green. Perhaps this is *Ichneumon rufiventris* (88: 1) reared by Dimmock from this chrysalis. Mr. Edwards also records an Hemipteron calmly sucking the caterpillars in one of their retreats. There is also a parasite of the egg, *Trichogramma intermedium* (89: 8) which comes out of it about ten days after its time of hatching.

Desiderata. The special attention of observers should be directed toward the seasons of this insect after midsummer, to determine whether there are certainly two broods in the latter half of the year. Doubtless some modification of the history given here would be necessary farther north. Is it anywhere single brooded? In New England, how large a proportion of the latest chrysalids remain unchanged through the winter? and what effect do they have upon the comparative abundance of the early spring flight of butterflies? The curious statements of Messrs. Fischer and Billings lead one to ask how often and under what circumstances chrysalids will disclose their inmates in so short a time as four or five days? Has weather any effect in changing the larval habits, as seems to be thought by Messrs. Edwards and Gilbert (Can. ent., xvii: 187-188)? Does it ever go into hibernation in August, as its European congener is said sometimes to do?

LIST OF ILLUSTRATIONS.—AGLAIS MILBERTI.

Egg.

- Pl. 64, fig. 36. Plain.
40. Cluster.

Caterpillar.

- Pl. 74, fig. 36. Mature caterpillar.
78: 54-57. Front view of head, stages i-iv.
81: 3. Nest, opened to show its construction.
4. Nest, outside view.
86: 66. Dermal appendage of fourth stage.

Chrysalis.

- Pl. 83, fig. 43. Side view.
49. Side view in outline.
50. Dorsal view in outline.

Imago.

- Pl. 2, fig. 7. Both surfaces.
12: 10. Upper surface.
33: 25, 26. Male abdominal appendages.
38: 13. Neuration.
53: 1. Side view of head and appendages enlarged, with details of the structure of the legs.

General.

- Pl. 20, fig. 6. Distribution in North America.
88: 1. *Ichneumon rufiventris*, a parasite.
13. Cocoons of *Apanteles atalantæ*, a parasite.
89: 8. *Trichogramma intermedium*, egg parasite.

SECTION II.

Wings of imago with rounded angles; male abdominal appendages having the hook of upper organ moderately large and not inconspicuous; inferior arms developed into long, backward directed appendages, replacing the basal upper process of the clasps which is entirely wanting; clasps as long as, or longer, than broad. Chrysalis much less strongly angulated than in the preceding group, the tubercles blunt.

GENERA: *Vanessa*, *Junonia*.

VANESSA FABRICIUS.

- | | |
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| <i>Vanessa</i> Fabr., <i>Ull. mag. ent.</i> , vi: 281 (1807);— | <i>Cynthia</i> Steph., [nec Fabr.], <i>Brit. ent.</i> , <i>Haust.</i> , |
| <i>Latr.</i> , <i>Consid.</i> , 440 (1810). | 47 (1827). |
| <i>Pyrameis</i> Hübn., <i>Verz. schmett.</i> , 33 (1816). | <i>Ammiralis</i> Rem., <i>Conspect.</i> , 10 (1832). |
| <i>Bassaris</i> Hübn., <i>Exot. schmett.</i> , 2 (1816-21). | <i>Phanessa</i> Soderfsky, <i>Bull. Mosc.</i> , x: 80 (1837). |

Type.—*Pap. atalanta* Linn.

And I admired and took my part
 With crowds of happy things the while:
 With open velvet butterflies
 That swung and spread their peacock eyes,
 As if they cared no more to rise
 From off their beds of camomile.

JEAN INGELow.—*Scholar and Carpenter*.

Imago (53:5). Head large, uniformly and densely covered with mingled longer and shorter hairs. Front moderately full, slightly protuberant in the middle or just below it, as broad as, or slightly narrower than, the eyes, slightly broader than high, the upper border hollowed in front of the antennae, rather broadly but prominently convex in the middle, the posterior extremity well rounded; lower border broadly rounded, the middle half nearly straight. Vertex small, rather tumid, transverse, subtriangular, with slender, lateral extensions; posterior border convex, anterior with a median convexity; posterior border of the eyes opposite that of the vertex; eyes large, full, sparsely pilose with short, delicate hairs. Antennae inserted in the middle of the summit in distinct, pretty deep pits, connected by a narrow but pretty deep sulcation, their bases distant from each other by twice the width of the antennal stalk, outwardly nearly touching the eye; more than half as long again as the abdomen, consisting of from thirty-nine to forty-one joints, the last eleven developing into a spatulate club, the last joint of which forms a minute, sharply pointed, short, conical tip, but otherwise broadly rounded at the extremity, the last four joints entering into the decrease of size; the club is two and a half times longer than broad and five times broader than the stalk, strongly depressed. Palpi compact, stout, two and a half times longer than the eye, the terminal joint about one-third as long as the penultimate, densely clothed with scales and the penultimate with a few rather short, erect hairs on the apical half above and a few similar but spreading, curved hairs on the lower half of the sides. Papillae occupying the apical twelfth of the tongue, of varying shape, slender, about four times as long as broad, or about as long as the width of one side of the tongue beyond the median canal, the tip truncate and cup-shaped, the rim with four or five thorns half as long as the central filament which is shorter than the width of the cup; situated beneath the outer edge of the tongue and so distant as to nearly leave room for two more between each pair.

Prothoracic lobes (61:37) large, reniform, tumid, of uniform length throughout, curving downward, the ends well rounded, half as high again as long and nearly four times as broad as long. Patagia scarcely convex, very broad and well rounded at the base, the basal three-fifths tapering very rapidly, the apical two-fifths forming a very slender, nearly uniform, equal, pointed finger, scarcely curving downward.

Fore wings (38:12) more than half as long again as broad, the costal border very broadly rounded, slightly more toward the apex; outer border broadly sinuous, reced-

ing most in the subcosto-median interspace, the apex rounded off; the inner margin nearly straight, slightly sinuous, the lower angle rounded. First superior subcostal nervule emitted a little beyond the middle of the outer two-fifths of the upper margin of the cell; second, half way between the origin of the first and the tip of the cell; third, at about the same distance before, as the base of the fourth is beyond, a point midway between the tip of the upper margin of the cell and the apex of the wing; second inferior subcostal nervule arising but a very short distance down the cell; the latter two-fifths the length of the wing and scarcely three times as long as broad. Last median nervule connected before the middle of its basal curve with the vein closing the cell.

Hind wings with the costal border pretty strongly arched at the very base, beyond nearly straight, a little bowed, the outer margin well rounded, scarcely less so in the middle half, slightly crenulate, the apex well rounded; the inner border enlarging at the base, beyond, to a short distance past the middle of the wing, straight, then roundly excised and continuing parallel to its previous course, the outer angle rounded. Precostal nervure originating at a little distance beyond the divarication of the costal and subcostal, nearly straight, forked at the tip, the largest fork directed outward; cell closed.

Fore legs small, cylindrical, the tibiae about one-half the length of the hind tibiae; tarsi three-fifths the length of the tibiae, both very profusely covered with long hairs spreading in a lateral plane, giving the whole leg a greatly appressed and feathery appearance, more conspicuous in the male than in the female; the tarsi consist of five joints of which the basal is twice (♀) or thrice (♂) as long as the others combined, and they equal in length among themselves; the terminal joint bluntly rounded and either unarmed (♂), or all armed at the tip beneath with a pair of very delicate and slender, minute spines, those of the terminal joint being apical (♀). Middle tibiae slightly longer than the hind pair; both furnished on either side of the lower surface and on the upper edge of the inner side with rows of frequent, pretty long and very slender spines, those of the latter row less frequent on the hind than on the middle tibiae; spurs very long and very slender. The second and fifth joints of tarsi about equal, the third slightly longer than the fourth, which is the smallest; first nearly as long as all the others together; all provided beneath on all the joints with four rows of crowded spines, similar to those of the tibiae, the apical ones of each joint a little stouter. Claws moderately delicate, very strongly curved, a little compressed, finely pointed. Paronychial about as long as the claws, slender, tapering, finely pointed, a little curved; pulvillus very small indeed, quadrate.

Abdomen compressed subfusiform, the upper organ of the male appendages moderately stout, the hook as long as the body, very stout, depressed, nearly straight, tapering, but very bluntly pointed; inferior arms pretty stout, bent toward each other in their basal half, beyond directed backwards horizontally side by side to about the centre of the clasp, or as long as the hook. Clasps subquadrate, a little longer than broad, the upper posterior angle slightly produced and incurved, the inferior border pretty regularly arcuate; interior finger tapering, nearly following the inferior border of the clasp, strongly arcuate or sinuate toward the tip and finely pointed; a secondary armature is found in the centre of the inside of the clasp.

Egg. Very short ovate, transversely circular, broad and rounded at the base, tapering a little to a broadly rounded apex, the diminution in size less apparent because furnished with a few very prominent, greatly compressed, longitudinal, regular and equidistant ribs, which increase in height toward the summit, where they terminate abruptly with a very high well rounded outline; surface between the ribs smooth, broken up by numerous delicate transverse lines. Micropyle composed of a few, comparatively large, pretty uniform, roundish cells arranged in a rosette.

Caterpillar at birth. Head smooth, the upper two-thirds nearly equal, broadest a very little above the middle, a little higher than broad, furnished with very few scattered long hairs, the hemispheres a little elevated and rounded at summit. Body nearly or quite uniform, armed with longitudinal rows of lit-

the warts, one to a segment in each row, each giving rise to a long, nearly straight, very delicate, tapering hair: they are arranged on the abdomen in a subdorsal row in the middle of the anterior half of the segment, a supralateral row on the posterior part, a laterostigmatal row just in advance of the middle and a low stigmatal row posteriorly, besides an infrastigmatal series slightly in advance of the middle: on the thoracic segments they are the same excepting that the laterostigmatal become infralateral, the subdorsal laterodorsal, and all are median. Legs apparently rather stout, prolegs with a circular series of nine hooklets.

Mature caterpillar. Head rather small, well rounded, scarcely subquadrate, broadest in the middle, the hemispheres scarcely tumid above, the suture between them a little and rather suddenly depressed, the sides rather broadly rounded, the front scarcely appressed, scarcely deeper below than above: triangle not very much higher than broad, extending fully half way up the head, covered pretty regularly and rather abundantly with larger and smaller subcylindrical, tapering warts, mostly but little higher than broad, but on the hinder margin becoming more elevated, and one a little more conspicuous than those about it on the outer anterior border of the summit of each hemisphere. Antennae with the second joint nearly as long as broad, the third not much slenderer but more than twice as long as broad, bearing a very long hair at the tip, the fourth a miniature of the third and quite inconspicuous. Ocelli six in number, five in a pretty strong curve, convexity forward, the second and third—counting from above—in contact, the fourth scarcely separated from the third, the fifth distant from the fourth by less, and the first from the second by rather more, than the diameter of one of them: the sixth is behind the others equally distant from the first and fourth and with them forms a right angle: they are all of equal diameter and prominent, but the second to the fifth peculiarly so. Labrum small, broad, well rounded, pretty deeply excised in the middle in front. Mandibles small, broad, not very stout, the edge straight, in the upper half faintly denticulate, in the lower half with three distinct but small, triangular teeth, a little longer than broad. Maxillary palpi with the first two joints about equal, broad and short, the third much slenderer, twice as long as broad, bluntly rounded at tip, the fourth small, but noticeable. Spinneret broad at base and rapidly tapering, beyond slender.

Body cylindrical, nearly equal, tapering slightly forward on the thoracic segments, armed with rather long and conspicuous spines, having a broad base. The spines are slender, straight and slightly tapering, terminating in a needle which is fully one-third as long as the spine and at base about half as broad as the tip of the spine. They are furnished at the sides with not very long and rather slender spinules, spreading upward at an angle of about 45° with the main stem and armed at tip like the spine: there are generally seven or eight of these irregularly disposed on the basal two-thirds of the spine, and, independent of their thorn, seldom more than one-fourth as long as the main stem. The spines are regularly arranged in longitudinal rows, one to a segment in each row, as follows: a dorsal series, placed anteriorly on the first to eighth abdominal segments: a laterodorsal series, placed centrally on the first to eighth abdominal segments: a lateral series, placed centrally on the second and third thoracic segments: a laterostigmatal series, placed anteriorly on the first to ninth abdominal segments, the last having two, one placed anteriorly and the other posteriorly: a stigmatal series, placed centrally on the second and third thoracic segments: and an infrastigmatal series, placed centrally or very slightly posterior to it, from the second thoracic to the eighth abdominal segments. The first segment is provided with a transverse series of long, papilliform tubercles, each with a long, curving bristle. The body is also furnished with numerous, very delicate, not very long hairs arising from the minutest warts. Spiracles moderately large, obovate, about half as long again as broad, legs equal, not very long, slender, tapering, the claw very slender, curving but little. Prolegs not very long, pretty stout, tapering, the hooklets as in *Envanessa*.

Chrysalis. Viewed from above, the prothorax and head taper very slightly and regularly, or not at all, to the tip of the ocellar prominences: the latter are stout, blunt projections, sometimes conical, but then low and with their inner edges slightly curved

and directed toward each other at a very broad angle—not less than 130° —and the space between slightly hollowed; at other times not projecting beyond the front which is very slightly hollowed, but a little swollen laterally and at a side view broadly arched, scarcely angulated at the tip; when conical, the upper edge is continuous with the line of the prothorax and the under, excepting for the prominence of the base, with that of the lower surface. Mesonotum considerably arched longitudinally, the anterior two-thirds of the middle line carinate; just beyond the middle the carina is rapidly and regularly elevated to a point of highest projection near the middle of the posterior two-thirds, shaped much as in *Euvanessa*, but with sides sloping at an angle varying from 50° – 80° . Front including all the appendages nearly or quite straight; a pair of rather small, conical, supralateral tubercles in the middle of the meso- and metanotum. Basal wing tubercle pyramidal, triquetral, rather pointed and prominent, the upper angle extending a very brief distance and furnished with a slight accessory tubercle. Secondary wing tubercle about as sharp and as elevated as the basal one, the space between them angulated nearer the latter; just above the middle of the posterior edge of the wings where they are swollen is a minute tubercle. Longitudinally the abdomen is very broadly and regularly arched, furnished with a dorsal series of minute, conical warts on the anterior edge of the second to eighth segments, a laterodorsal series of not very large conical tubercles on the middle of the first to eighth segments, sometimes obsolete on the eighth, largest on the second to fourth segments; a suprastigmatal series of minute warts a little in advance of the middle of the first to ninth segments, occasionally obsolete and marked only by spots; an in every respect similar infra-stigmatal series on the middle of the fourth to eighth segments. Preanal button with a coarse, curving, longitudinal pair of ridges, sometimes scarcely elevated, each terminating in a forward directed, linear, rounded tubercle much longer than broad. Cremaster on a dorsal aspect tapering considerably to a rounded rather narrow tip, twice as long as the medium breadth, greatly and roundly hollowed; on a side view equal, curved a little, expanded at the tip, particularly upon the under side, the apical field of hooklets longitudinally oval, sometimes two or three times as long as broad. Hooklets with a long, equal, moderately stout, and slightly curved stem, the apex enlarging a little only, strongly crooked, the bluntly rounded, but slightly produced, downward directed tip distant from the stem by the width of the latter.

Distribution. This genus is found in almost every inhabited quarter of the globe; we find one of its members, *V. cardui*,—the most cosmopolitan of all butterflies,—spread over nearly all the world, its area of dispersion embracing every zone whether of altitude or of latitude as far as the arctic or glacial regions. As already remarked by Doubleday, everywhere it is accompanied by one or more members of the genus. The companion species too, at least in the Old World, is taken from the opposite section of the genus, comprising the species marked like *V. atalanta* with a brilliant bow upon their upper surface; “*cardui* has for its compatriot in Europe and North America *Pyrameis atalanta*; further south in the Old World, *P. callirhoe* [*indica*]; in Java, *P. dejeanii*; in Australia, *P. itea* and an undescribed species [*P. leachiana*], of which I have only seen the fragment in the collection of the British Museum; in New Zealand, *P. itea* and *P. gonerilla*; in the Sandwich Islands [Hawaiian Islands] *P. tammeana*” (Double.-Hew., Gen. diurn. Lep., 204), and he could have added: in south Africa, *P. hippomene*. In the New World it is also accompanied by a species from the same section as itself, *V. huntera*, throughout the whole breadth of North America, and by *P.*

carye on the Pacific slope. Where *cardui* disappears, *huntera* too generally fails, and in South America is replaced first by one species and then by another, "and if these species coexist," says Doubleday, "one is sure to be rare, for this coexistence is only found on the very limits of their respective territories." In the east *huntera* is replaced by *myrinnia*, in the west by *carye*; further south it reappears in *terpsichore*, which Berg says is identical with *huntera*. It seems, however, to have escaped observation that, with the exception of the two species common to Europe and America, all the species of the Old World belong to the *atalanta* section (*Pyrameis*) and all those of the New World to the *cardui* section (*Neopyrameis**) ; so that in discussing the original birthplace of these two now widely spread butterflies we may reasonably lean toward the hypothesis that *cardui* originated in the New, and *atalanta* in the Old World ; notwithstanding that in America *cardui* feeds almost entirely on plants introduced from Europe (or are they possibly indigenous to America and thence introduced into Europe?). Of the four North American species of *Vanessa*, three occur throughout nearly or quite the whole of New England. Two of these are the species common to Europe and America, and the third ranges from the Atlantic to the Pacific and from the limits of the settled parts of Canada to Guatemala.

Subordinate groups. As above stated, the species of this genus fall very naturally into two groups when the structure and appearance of the imago and the habits of both larva and imago are discussed ; but the same is not true when the structure of the larva and pupa is taken into consideration ; showing that these groups should only be considered at most subgeneric. The insects are of medium size. In the most numerous Old World section (*Pyrameis*) the wings are almost black above, the hinder pair broadly bordered with red over most of their outer margin, forming a band which, when the wings are spread, is continued across the middle of the fore wings ; on the latter it starts from the costal margin at one-third the distance from the base and runs towards the outer angle, curving slightly downward before reaching it. In the other section (*Neopyrameis*), where the ground color is not so deep, this band is indeed present on the fore wings, but paler in tint and so excessively irregular and broken in outline as scarcely to be recognized, and it is accompanied by similarly colored spots in the middle of the cell and of the medio-submedian interspace, which help to obscure its limits ; on the hind wings the whole apical half or two-thirds of the wings is of the brighter color with a submarginal series of dark roundish spots rather distant from the outer border and sometimes pupilled with blue. In both sections the outer border of both wings is more or less enriched by alternate markings of dark and bright spots or lines, and on the fore wings there is in addition a curving row of

* Name here first proposed.

unequal spots and a transverse patch of white or some bright color depending from the costal border. Beneath, the markings of the fore wings in each section are much the same as above though more variegated; the hind wings are alike in the two sections, infinitely diversified with dark and light markings taking for the most part a transverse direction, darker shades prevailing to a greater extent in *Pyrameis* than in *Neopyrameis*, and provided, conspicuously in *Neopyrameis*, inconspicuously in *Pyrameis*, with a submarginal series of rounded ocellate spots, varying in size and abundance in the different species. The two groups differ also, as Doubleday pointed out, in having the paronychial distinctly bilacinate (*Pyrameis*) or the inner lobe rudimentary (*Neopyrameis*); there are further differences, pointed out beyond, in the male abdominal appendages.

History and characteristics. In the temperate parts of America at least, the species are all double-brooded and all hibernate as imagines and probably also sometimes as chrysalids, the hibernating butterflies and the butterflies from hibernating chrysalids flying at about the same time in spring. The first brood of caterpillars appears in early June, and the second early in August.

The eggs are laid singly, usually upon the upper surface of the leaves of Compositae (especially of the tribes Cynaroideae and Inuloideae) and of Urticaceae, — the former family of plants being the food by preference of the known larvae of *Neopyrameis*, the latter of those of *Pyrameis*. The caterpillars live singly, usually in vertical nests; those of the section *Pyrameis* constructing theirs of a single leaf, the lower portion of which they gradually devour, while the caterpillars of *Neopyrameis*, at least after attaining half their growth, form their nests of several leaves, feeding only upon the parenchyma of the upper surface of these leaves, until nearly mature. When the insect completes its metamorphoses before winter, the chrysalis usually hangs from ten to twelve days, but its time may be as short as eight or as long as fourteen.

The butterflies have a rather powerful flight, irregular and wayward, and are exceedingly active, although they frequently settle; the *Pyrameides* sometimes sail, the *Neopyrameides* very rarely; they are all fond of flowers and ripe fruit. On alighting they turn suddenly about away from the sun, expanding their wings fully, sometimes even depressing them; the antennae are straight, nearly or quite in the plane of the body and spread at about right angles. The fore wings are often partially raised and are then placed at a slight angle with the hind wings, the inner border of the former resting on the plane of the latter. When at rest in the shade, the wings are closed back to back and the antennae, raised at a considerable angle, are much less divaricate. When at rest at night, the antennae are raised at right angles with the body, i. e. nearly perpendicular, and scarcely divaricate.

The eggs are very short ovate, broad at the base, furnished with very prominent laminate ribs, which increase in height toward the summit where they terminate suddenly; these ribs vary in number in the two sections, being more numerous (fourteen to nineteen) in *Neopyrameis* than in *Pyrameis* (nine).

The juvenile larvae have a smooth head with long hairs irregularly scattered, and a uniform body supplied with three longitudinal rows of little warts above the spiracles, two more nearly on a line with them and two just below,—each wart emitting a long, tapering hair.

The full-grown caterpillars are brown, varying from yellow to black, with a pale interrupted lateral band and sometimes a lateral row of white spots on most of the abdominal segments; they are also furnished with bristly spines arranged in eleven regular longitudinal rows.

The chrysalids are not so strongly angulated as those of the preceding genus and are furnished with prominent ocellar tubercles; they are generally more or less olivaceous and ornamented with gilded nacreous spots.

*EXCURSUS XIII.—BUTTERFLIES COMMON TO THE OLD
AND THE NEW WORLD; WHERE DID THEY
ORIGINATE?*

Dank euch, allerkleinste Leben
Kinder der verjüngten Monde!
Deren Wunderbildung
Farben und Geschäfte,
Froh mein forschend Aug' besah.

DENIS.

IF we bear in mind the continuity of land between South America and North America, we shall not be surprised at finding, at least along the borders, some butterflies which are found on both continents; but considering what wide oceans separate on either side the Old World and the New, and that their points of contiguity are in extreme northern latitudes, we might expect a greater absence of Old World forms in North America. Yet if we separate from the bulk of butterflies of this continent those which are found south of the Canadian border and east of the Rocky Mountains, we shall find, out of the somewhat less than two hundred and fifty species occurring therein, not over a dozen which may be fairly considered identical with butterflies found in the Old World, whether in Europe or in Asia. The identity of some of these, many writers have questioned; about some there is no doubt whatever, while there are others which approach in appearance those of the Old World so closely that naturalists are still in dispute concerning them. Let us consider a few of these separately, that we may gain some idea as to the nature of their peculiar distribution.

In the first place, there is one species, *Pieris rapae*, whose introduction into this country is a matter of history, and of whose immediate European origin there is therefore no question. There are three others, *Eu Vanessa antiopa*, *Vanessa cardui* and *V. atalanta* which do not vary in the slightest degree from the same species in the Old World, although some writers have at times thought that they could pick out the American and European forms when mixed in the same collection. *Eu Vanessa antiopa* is very widely distributed, covering almost the entire North American continent excepting arctic and subarctic lands, and even here it extends within the latter to Alaska. In the Old World it has an equally wide distribution, being found over the whole of Europe excepting southern Spain, and over all of northern Asia. It is an insect of strong flight, and being found upon both sides of Bering Strait, could unquestionably pass from one continent to the other at this point of their nearest approach. In which continent the species originated must be judged rather from the abundance and variety of its nearest allies on the one continent and on the other. In America there is but a single additional species of the genus occurring, and that so rare that I am not aware that more than one specimen has ever been found, occurring as it does in the mountains of Mexico. In the Old World several species occur in southern Asia, but in addition there is a very closely allied genus, *Inachis*, which occurs in Europe but not in America, and it is therefore in the highest degree probable that the origin of the species should be looked for in the Old World. As to the two species of *Vanessa*, we have shown in our account of this group that the genus is divisible into two sections, into one of which *cardui* falls, into the other *atalanta*, and that the immediate congeners of *cardui* are found altogether in the New World and those of *atalanta* in the Old. The distribution of these species in the New World being more restricted than that of *E. antiopa*, so that there is no probability of any recent transfer of forms between the two continents, we are left entirely to the consideration of their allies to judge in what part of the world they originated, and on this basis there can be no question whatever that *cardui* originated in America, and *atalanta* in the Old World.

Two other species are in nearly the same category as the last as regards their distribution on this continent. These are *Cyaniris pseudargiolus* and *Heodes hypophlaeas*, which many writers are inclined to consider identical with *argiolus* and *phlaeas* of the Old World. There can be no doubt of their exceedingly close affinity, nor, on the other hand, of the fact that whether species or variety, the forms existing in the New World can be separated from those of the Old. With regard to *Heodes*, there is but a single species of the genus, in its restricted form, in either hemisphere. In each it extends from ocean to ocean, although not found in the high north, and inasmuch as the genera nearest to it are also represented by species in each

hemisphere (more abundantly in the Old World than in the New), it is difficult to form any proper judgment concerning its place of origin, though it would appear more probable on general grounds that it originated in the Old World. The same general statements are true to a large extent as regards the species of *Cyaniris*. There is a single form on each continent which extends across its entire width, but is not found in the high north. As in *Heodes* also, its immediate relatives are found in greater abundance in the Old World than in the New; but on the other hand the development of varietal forms within the species is so greatly in excess in America, that we must conclude it probable that its life on this continent has been longer than on the Old.

There remain only those species which occur within our district but which belong more properly to high boreal regions. Among these we have first a species of *Oeneis* (*O. jutta*) which is unquestionably identical on the two continents. Its distribution on this continent is probably much more extensive than known, as it has been found at widely distributed localities. The genus to which it belongs is a characteristically alpine and arctic group, and is so widely developed on both continents that here again it is extremely difficult to decide as to the probability of its origin. Often living close beside the ice, it has undoubtedly been a companion of the terminal moraine throughout the ages. One indication might at first lead us to suppose that the life of the genus may have been the longer in Europe. This is the fact that in the Alps of Switzerland there is a species very clearly distinct from any found in the north, while on our own high mountain-tops *O. semidea* is considered by many writers as identical with a species found in Labrador. But both are waifs left by the glacial epoch. Still, the bulk of genera to which the satyrids of Europe are referred belong to the section with ribbed eggs, in which *Oeneis* falls, while the contrary is true of the American forms. It would seem, therefore, as probable (though highly uncertain) that *Oeneis* originated in the Old World.

All the other species, in the opinion of most critical entomologists, are different from those of the Old World, but in all cases they approach so closely to them that many writers have considered them as identical. *Polygonia faunus* is a case in point. It has been considered as identical with one of the forms of the variable *Polygonia c-album* of Europe; but the facts in the case would seem to show that, whereas the species of the Old World are few and variable, those of the New are numerous and closely allied, and at the same time frequently dimorphic or even polymorphic. The excess to which variability has extended in this country would therefore seem to indicate this as its older abode. The opposite is probably true of *Eugonia*, represented in this country by a single species; this is considered by many as identical with *Eugonia vau-album* of Europe.

which has there for its companion many very closely allied species. *Pieris oleracea*, almost our only native species of *Pieris*, considered by many as the same as *Pieris napi* of the Old World, has also many allies in the Old World, and therefore, like *Pieris rapae*, probably originated there. Finally *Pamphila*, represented in this country by only a single species, *P. mandan*, widely separated from all its allies, a strong flier and extending to Alaska, belongs to a genus represented in the Old World with its immediate allies by several peculiar types, which range across the entire breadth of the continent; we must therefore look upon this species as one introduced from the Old World, but at a period of time so long ago as to have become fairly distinct from the primal stock.

If now we turn our attention to the butterflies found north of our boundary and not extending into it we shall find a considerable assemblage of species, from twenty-five to thirty in number, belonging to as many as thirteen genera; and we shall at once be struck by the fact that in every case these genera are represented either by the same or by allied species in the Old World; and what is more, that in all cases but one they are more, often much more, bountifully supplied with distinct forms in the Old World than in the New. Thus we find two species of *Oeneis*, both of which occur in Europe, four of *Erebia*, and two or three of *Coenonympha*, all considered distinct from those of Europe, and confined to the western half of our continent; five species of *Brenthis*, of which three are looked upon as identical with those of Europe, and one of *Lemonias*; one each of the lycaenid genera *Cupido*, *Agriades* and *Epidemia*, all distinct from the European species, five or six species of *Eurymus*, of which at least two are found in Europe, one of *Pontia*, two of *Parnassius*, one of which is found in Europe, the same of *Papilio*, and finally one of *Erynnis*, which also occurs in Europe. This last genus is the one to which we referred as being far more developed in America than in Europe; indeed, the European species, *E. comma*, is only known upon our continent by a varietal form occurring in Labrador.

Of the above thirteen genera we further notice that the species of no less than five of them,—*Erebia*, *Coenonympha*, *Lemonias*, *Cupido* and *Parnassius*, including a dozen of the species,—are altogether confined to the western half of the continent, and show a distinct geographical relation to Alaska. While on the other hand, not one of the genera is confined to the eastern half; and besides this not any genus of American butterflies not found in Europe, with the sole exception of *Phyciodes* and *Basilarchia* (by a single species in each case), shows any special tendency to extend its domain toward Alaska. The avenue of migration is thus clearly marked.

It would seem therefore very clear that the identity or intimate resemblance which occurs in certain species between the butterflies of Europe

and America is due altogether to their boreal character; that their occurrence on the two continents, looked at from a broad point of view, must be regarded as the consequence of a continuity or close proximity of land during later tertiary times when a warm climate prevailed in the high north; and that the distinction between them, and even the representation of the same genus on the two continents by clearly different species, is due to the subsequent separation of the two regions in glacial and post glacial times, and the variations which isolation, a difference of climatic conditions, and their general environment have brought about in the lapse of time.

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The literature upon this subject is largely polemical, very scattered, and generally brief. Walsh published in 1864 in the Proceedings of the Entomological society of Philadelphia a list of butterflies said to be common to North America and the Old World; Möschler has considered the matter in his papers on the Lepidoptera of Labrador, mostly in the Stettiner entomologische zeitung; Zeller in his review of Edwards's Butterflies, and various papers by Speyer and Möschler in the same journal also discuss it. See also my comparison of the butterfly faunas of Europe and America in the Proceedings of the American association for 1876.

Table of species of Vanessa, based on the egg.

Vertical ribs less than twelve in number (<i>Pyrameis</i>).....	<i>atalanta</i> .
Vertical ribs more than twelve in number (<i>Neopyrameis</i>).	
Egg not more than one-tenth higher than broad.....	<i>huntera</i> .
Egg about one-third higher than broad.....	<i>cardui</i> .

Table of species, based on the caterpillar at birth.

Upper hairs of body nearly straight, hardly more than half as long as width of head (<i>Pyrameis</i>).....	<i>atalanta</i> .
Upper hairs of body considerably curved, about three-fourths as long as width of head (<i>Neopyrameis</i>).	
Body highly variegated.....	<i>huntera</i> .
Body of nearly uniform tint.....	<i>cardui</i> .

Table of species, based on the mature caterpillar.

Lighter markings in front of supralateral spines consisting of conspicuous round spots.....	<i>huntera</i> .
Lighter markings in front of supralateral spines consisting of slender, inconspicuous, longitudinal streaks.	
Spinules of apical circle as long (not including the terminal thorn) as the spine below the circle.....	<i>cardui</i> .
Spinules of apical circle not one-third so long (not including the terminal thorn) as the spine below the circle.....	<i>atalanta</i> .

Table of species, based on the chrysalis.

A distinct supralateral tubercle on either side of the eighth abdominal segment.	
Supralateral tubercles bluntly conical.....	<i>huntera</i> .
Supralateral tubercles sharply conical.....	<i>atalanta</i> .
No distinct supralateral tubercle on eighth abdominal segment.....	<i>cardui</i> .

Table of species, based on the imago.

The orange colors on upper surface of fore wings confined to a single transverse belt (*Pyrameis*).....**atalanta**.
 The orange colors on upper surface of fore wings not confined to a single belt (*Neopyrameis*).
 Two large ocelli on nuder surface of hind wings, each broader than an interspace.**huntera**.
 At least four ocelli on under surface of hind wings, never broader than an interspace.....**cardui**.

GROUP I (Pyrameis).

Wings of imago marked above with a conspicuous bright colored bow, which crosses the middle of the fore wings and margins the hind pair. Under surface of same without conspicuous ocelli. Hook of upper organ bifid at tip; clasps tapering a little and squarely docked at the tip; secondary armature transverse.

VANESSA ATALANTA.—The red admiral.

[The red admiral (Auct.); atalanta vaness (Emmons); atalanta butterfly (Harris).]

Papilio atalanta Linn., Syst. nat., 10th ed. 478 (1758).

Vanessa atalanta Fabr., Ill. mag. ins., vi: 281 (1807);—Boisd.-LeC., Lép. Amér. sept., 175-177 (1833);—Kirb., Faun. bor.-amer., iv: 294 (1837);—Pack., Monogr. Phal. U. S., 28, pl. 7, fig. 20, 20a (1876);—Scudd., Butt., 110-111, 139-140, figs. 13, 72, 95, 128 (1881).

Nymphalis atalanta Latr., Hist. nat. crust. ins., xiv: 86-87 (1805).

Aglaïs atalanta Dahn., Kongl. vetensk. acad. handl., xxxvii: 65 (1816).

Pyrameis atalanta Hübn., Verz. schmett., 33 (1816);—Morr., Syn. Lep. N. Amer., 58-59 (1862);—Edw., Can. ent., xiv: 229-234 (1882);

xv: 14-20 (1883); xvii: 179 (1885);—French, Rep. ins. Ill., vii: 153 (1878); Butt. east. U. S., 196-198 (1886);—Middl., Rep. ins. Ill., x: 86 (1881);—Fern., Butt. Me., 59-60, fig. 20 (1884);—Mayn., Butt. N. E., 18, pl. 20, 20a (1886).

Libythea atalanta Lam., Anim. sans vert., iv: 29 (1817).

Hamadryas decora atalantu Hübn., Verz. eur. schmett., 2 (1822).

Cynthia atalanta Harr., Hitehe. Rep., 590 (1830); Entom. corresp., 279 (1869).

Papilo amiralis Retz., Gen. sp. ins., 31 (1783).

Figured by Glover, Ill. N. A., Lep., pl. 22, fig. 1; pl. 33, fig. 4.

Voici le Vulcain rapide.
 Qui vole comme un oiseau:
 Son aile noire et splendide
 Porte un grand ruban ponceau.

GÉRARD DE NERVAL.—*Les Papillons*.

Imago (2:6; 12:5). Head covered with mingled bluish gray and reddish brown hairs, sprinkled with a few black ones; the scales in immediate proximity to the hinder edge of the eye are pearly white, behind that brown and white. Palpi white exteriorly, fringed below with long, blackish hairs, the upper half of the apical three-fifths of the middle joint covered with dark yellowish brown and black scales and hairs; apical joint like the dark portions of the middle joint but with a few white and yellowish white scales beneath; interiorly the palpi are dusky above with a median line of spreading, white scales near the upper edge; beneath and on the lower portion of the inner side dirty yellowish white. Antennae beneath yellowish brown; elsewhere black, the base of each joint broadly annulated with white, most broadly at the sides, interrupted by the brighter color beneath; the basal six or seven joints have but little or none of this above; club velvety black, touched with white only at the extreme base, the apical four joints above, the apical two joints below, pale straw yellow. Basal third of tongue luteous, beyond brownish fuscous, luteo-fuscous centrally, the extreme tip luteous; papillae (61:29) indian-club shaped, twice as broad in middle as at base, appressed.

Prothorax clothed like the head, the gray hairs predominating and a few white scales

appearing at their base; the rest of the thorax covered with metallic bronze green scales, concealed by long brownish, olivaceous and mouse-brown hairs, the patagia also with mingled bluish gray and reddish brown hairs; beneath with reddish brown and white hairs, the former predominating. Fore legs marked down the middle of the front by a black streak, vaguely interrupted with white at the tip of the tibiae, fringed heavily on both sides with pale reddish brown and dirty yellowish white hairs: femora of other legs purplish brown, heavily flecked with pearly scales, the apex yellow; tibiae and tarsi pale yellow with a few black scales above, especially on the tarsi. the under surface of the latter castaneous. Spines piceous, spurs castaneous; claws blackish castaneous, the upper pair especially a little luteous at base within; pulvillus piceous.

Wings above lustrous purplish black, the base of the fore wings almost as far as the mesial band and the whole of the hind pair, excepting in close proximity to the marginal band, with a slight olivaceous reflection. Outer border of *fore wings* strongly sinuate, the upper portion straight, its lower angle scarcely rounded, the lower portion broadly rounded. Third superior subcostal nervule arising as far from the base of the second as that of the fourth from the tip of the wing, and twice as far as from the origin of the fourth superior nervule. A few dull orange scales on the costal border: a slightly irregular mesial band, uniform in width (the portion in the cell half as broad as long), mostly straight, curving inward below, of a bright orange color, brightest above, excepting next the costal edge where it is yellowish; the outer border of the band crosses the cell just within the outer limit of the latter; next the costal edge it curves inward; below the cell, it starts from the lower outer angle of the same and continues parallel to the previous portion, as far as the middle of the lower median interspace; here it begins to curve inward subparallel to the outer border and terminates on the submedian nervule, rounding back upon the interior border, which, below the costal nervule, has followed the same course excepting that it crosses the median by a nearly or quite straight line and in the middle of the lower median interspace has a slight projection which occasionally becomes produced into a slight stripe, breaking the band; in the middle of the cell, depending from the upper margin and not reaching the lower, is a transverse black subreniform bar, whose outer limit forms a portion of the interior margin of the mesial band, edged narrowly and inconspicuously with orange, excepting above and occasionally below; within this the cell and medio-submedian interspace are furnished frequently with some orange scales. Depending from the costal border, midway between the mesial band and the apex of the wing is a transverse bar of pure white, as broad as the width of the interspaces it crosses, reaching the lowest subcostal nervule and traversed by black veins; its exterior limit is a little powdery but its interior is sharply defined, encroaches a little on the bar at the penultimate subcostal nervule and causes it to narrow suddenly at the costal edge; the whole bar has a general direction between that of the upper portion of the outer margin and that of the mesial band; depending again from the costal margin, midway between the exterior edge of the bar just mentioned and the outer margin, is a curving series of five white spots, subparallel to the outer border, the first crossing two interspaces, irregularly crescent shaped, opening outward; the second a minute spot in the middle of the next to the lowest subcostal interspace; the third a little larger round spot in the middle of the lowest subcostal interspace; the fourth a larger, roundish quadrate spot crossing the whole of the subcosto-median interspace, its exterior edge a little more distant from the outer border than the width of an interspace; the fifth similar to the third, distant from the outer border by a space fully equal to an interspace and a half. Removed from the outer border by half the width of an interspace, in the subcostal and median area, is a vague series of scattered violet or pinkish scales. Fringe white, occasionally infringing on the margin in the middle of the interspaces, interrupted broadly though not very abruptly at the nervule tips with blackish. Outer margin of *hind wings* rather strongly and pretty uniformly rounded, bordered with orange from the middle subcostal nervule to the submedian nervule, to the width of an interspace and a half, and to a less extent in the upper subcostal interspace, where it

is diminished by a large, blackish spot less than an interspace distant from the border; in the middle of this orange border, in the middle of each interspace, is a small, roundish, black spot or dot, replaced in the medio-submedian interspace by a large, narrow, transverse, black spot crossing the whole interspace and largely dotted along the middle with pale blue scales often forming a double spot; the inner border is blackish as far as the outer margin and is dotted just above the interior extremity of the spot just mentioned with very pale blue scales, forming a streak as long as that previously mentioned. There is a narrow, submarginal line of black scales in the medio-submedian interspace and occasionally to a slight degree in the other interspaces. Fringe white, interrupted narrowly with black at the nervure tips.

Beneath, the *fore wings* are lustrous purplish black, the mesial band and bordering cellular spot repeated beneath, but the band of a rose-red colour, excepting below, on the greater portion of the medio-submedian interspace, where it is dull yellow; and above, including the upper margin of the cell and sometimes the exterior third of the portion of the band contained within the cell, where it is pale, bluish nacreous, tinged with yellow on the costal edge and costal nervure; the costal margin within the band is transversely and largely banded with delicate stripes of pale metallic blue; and a narrow curved streak of the same crosses the middle of the basal half of the cell, enlarging downward; the extreme base of the cell, especially along the subcostal nervure, and the base of the costal edge are sprinkled with brownish and snuff-colored scales; the white transverse costal band of the upper surface and the curving row of white spots are also repeated beneath, but the band has become of a very pale bluish white, yellowish at the costal edge, and the upper crescent shaped spot is replaced by a white dot in each interspace, encircled by dark reddish brown,—all much more conspicuous in the upper of the two; the two succeeding spots are also partially encircled by mingled metallic green and metallic blue scales in a blackish fuscous field, followed interiorly by a semicircle of pale blue, brown and yellow scales, capped by a similar, delicate, transverse semicircle of purplish black scales; midway between the costal bar and the median band, but widely separated from both and reaching from the costal margin to the median nervure, is a very large, irregularly quadrate patch of metallic blue, enclosing a large black field, partially powdered with blue. Beyond the transverse costal bar and above the lowest subcostal nervule the wing is differently colored; the upper two white dots are in a small, quadrate, costal field of yellowish white, mostly yellowish exteriorly, white interiorly; between this and the transverse band the costal margin is purplish black and brownish fuscous, with a small, median, costal, yellowish spot; the costal band is narrowly edged externally with purplish black, beyond which, as far as the spots in the lower two subcostal interspaces, brownish fuscous scales are succeeded by and partially irrorate with those of a yellowish fuscous colour; beyond the upper white dots, each of the interspaces is filled half way to the margin with a large brownish, somewhat greenish, fuscous spot, edged externally with an inward opening crescent of reddish brown. The outer margin is narrowly edged with dull, brownish yellow, interrupted at the nervure tips, very broadly below and also in the lowest subcostal interspace, with black, more or less enlivened with reddish; this is followed by a more or less interrupted or obsolete, whitish or bluish white, or clouded, narrow stripe, most distinct in the subcosto-median and upper median interspaces, broadest in the upper subcostal interspaces, where it meets the markings already described; this stripe is separated from the marginal edging by a narrow black line, interrupted on the nervures, represented on the upper subcostal interspaces only by a central dot in each interspace; in the lowest subcostal, the subcosto-median and in part in the upper median interspaces, this is followed after a black edging by a narrow stripe of metallic green scales, some of which are sometimes seen in the penultimate subcostal interspace. Fringe white, interrupted abruptly and rather broadly at the nervure tips with black. *Hind wings* greatly varied; the basal color is made up of a commingling of pale brown and brownish fuscous scales, all slightly tinged with olivaceous; the extreme base of the cell and of the costo-subcostal interspace is filled with black scales, having a common

sinnous exterior bordering of bluish white and yellowish white scales, and interiorly more or less enlivened by similar or by dark red scales. Scarcely beyond the middle of the cell is a velvety black figure-of-eight spot, crossing the whole of the cell and narrowly edged, exteriorly and interiorly, but not within, with white scales; just beyond it, a slender, irregular, broken, tortuous stripe of dark red scales crosses the wing; the extremity of the cell is marked by a narrow bordering of velvety black, enclosing a black or olivaceous brown nervule, the portion within the cell extending to the last divarication of the subcostal nervure, and there curving over outward into the upper subcostal interspace; that outside the cell crossing both these interspaces and in the upper curving upward to meet the upper portion. Basal half of costal border more or less spotted with dark red, interrupted by pale, dirty yellow scales; on the costal border, its interior margin just above the divarication of the subcostal nervure, is a large yellowish white patch, extending half way to the extremity of the costal border and downward, greatly narrowing in its course, half way or wholly across the costo-subcostal interspace, interruptedly edged, interiorly and exteriorly, with black, sometimes in broken continuation of the branches of the black spot at the extremity of the cell. A short distance beyond the tip of the cell the wing is crossed by a pair of irregularly parallel, tortuo-sinnous, delicate lines, the inner blackish, the outer dark red, distant from each other by half the width of an interspace, the inner from the extremity of the cell by double that distance. There is a series of large, roundish or oval, blackish fuscous spots, each occupying the whole width of an interspace, their outer edges coinciding with the interior border of the marginal orange band of the upper surface, those in the subcosto-median and upper median interspaces being almost wholly tinged with dull metallic green, the others pupilled with brighter green, all having a delicate pale edging, surmounted interiorly by a black crescent and followed exteriorly by a moderately broad band of yellowish brown, mingled with some dark red scales, and this again, at about three-quarters of an interspace's distance from the outer border, by a narrow, often interrupted stripe of metallic blue and green scales in a black field, broadest and somewhat sagittate in the centre of the interspaces; the large spots are only conspicuous in the subcostal, subcosto-median and median interspaces where the submarginal metallic stripe is narrowest; in the medio-submedian interspace, its place is occupied only by the black surmounting. The outer bordering is dull white, having a pale pinkish hue, more or less sprinkled, especially in the upper third of the wing, with blackish scales, the margin itself narrowly edged with alternate patches of dark red scales mingled with black and dirty yellow, the former at the nervure tips, the latter surmounted, in the middle of the interspaces, by slender, tapering black dashes. The inner area is mostly occupied by a grayish commingling of yellowish white and blackish scales, but also enlivened by metallic, reddish and brown scales, scattered irregularly throughout and by transverse lines of clustered scales of the same colors, mostly in continuation of those in the middle of the wing. Inner half of the wing covered with a few scattered, not very long white hairs; fringe as above.

Abdomen above purplish black, covered, especially near base, with long, brown hairs; beneath with mingled, dull olivaceous brown and dull, pale yellow scales, sometimes one and sometimes the other predominating. Appendages of male (33: 29, 29a): upper organ pretty large, body compressed above, strongly arched transversely, straight longitudinally; hook as long as body, the basal four-fifths stout and rigid, arched transversely, but slightly depressed, tapering, the apical fifth equal, bifid, formed thus of two lateral pieces, their apices pointed and slightly incurved; inferior arms stout, equal throughout, bent at nearly a right angle in the middle, bluntly rounded at the tip. Clasps of about equal length and breadth, half as broad again at the base as at the tip, with the lower and hinder edges slightly incurved, the upper posterior angle slightly produced and bearing a minute, short, tapering spine, incurved and directed a little upward; interior finger compressed, horizontal, very long, scarcely tapering until near the tip, nearly straight, curving a little inward and upward toward the tip, scarcely reaching the extremity of the clasp. In addi-

tion, crossing the middle of the clasp, is a ridge, its edge facing backward, at the middle produced to a finely-pointed, minute tooth.

Measurements in millimetres. Length of tongue ♂ 13, ♀ 14.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length fore wing.....		31.5		29.5	32.	35.
antennae		17.		14.5	16.	17.
hind tibiae and tarsi.....		10.75		5.	5.8	6.
fore tibiae and tarsi.....		6.		5.25	5.75	5.75

Described from 1 ♂ 5 ♀.

Hybrids. Mr. H. Edwards describes a hybrid between this species and *V. carye*, raised in California by Dr. H. Behr from a caterpillar found on nettle, as follows:—“The spots across the primaries form a bent macular band, the subapical spot being red and not white as in *atalanta*, the base of the wing behind the band being rusty red. The secondaries are blackish nearly over the whole surface, with reddish hairs, which are longest toward the base; the submarginal row of ocelli similar to those of *carye*, only with white pupils. The under side is that of *atalanta*, the abdomen being neither black nor red, but brownish, the color of the anal margin of the hind wings.” (Pac. coast Lep., 22, 9.) Hybrids among butterflies are of extreme rarity.

Aberrations. A “yellow variety” is mentioned as exhibited in London (Entom. xvi: 276).

Malformations. In 1865, Mr. W. F. Evans exhibited to the Entomological society of London two malformed specimens of this species, one of which, caught near Bradford, Yorkshire, had the left antenna only half the length of the right, notwithstanding that it possessed the usual number of joints; the other, bred from the larva, had the wings on one side considerably larger than on the other.

Egg (64: 24). Laminate ribs nine in number, commencing at the sides of the base and leaving on the summit a free space .2 mm. in diameter; they are .02 mm. high in the middle of the egg, and .07 mm. high at the summit; surface glistening, broken up by delicate transverse lines, .03 mm. apart, only minutely raised above the surface excepting where they traverse the ribs; here they are more distinct, especially above, being thickened at the edges. Micropyle rosette .07 mm. in diameter, or fully half the diameter of the space between the termination of the vertical ribs; it consists apparently of a minute central cell, surrounded by a network of nearly equal subcircular cells, about .0127 mm. in diameter, deeply depressed, separated by tolerably broad walls, and arranged irregularly in about three concentric rows, the outer cells transversely oval. Color delicate green, the ribs pellucid. Height (including the ribs), .74 mm.; breadth at base, .6 mm.

Caterpillar. *First stage* (70:10). Head (78:58) very dark and body pale but having only mounted specimens to describe, the colors cannot be accurately determined; hairs (86: 61) brownish, exceedingly long, sometimes curving a little. Length, 2.25 mm.; length of longest hair, .26 mm.; breadth of head, .34 mm.

Second stage. Head piceous, with a few pale hairs arising from excessively minute papillae. Body dark olive green, with a russet tinge, strongly infuscated on the thoracic and the dorsal area of the first three abdominal segments; an obscure pallid substigmatal stripe. Spines (86: 62) black, slightly shorter than the apical curved hair; posterior dorsal papillae of eighth abdominal segments yellowish. Length, 4.5 mm.

Third stage. Head as before, the tubercles larger, almost conspicuous, especially when, as sometimes, they are white. Body very dark mahogany brown, sometimes with an olivaceous tinge, often almost, and sometimes on thoracic segments quite, black, the terminal segments and under surface a little lighter than the rest, the hinder dorsal tubercle of eighth abdominal segment sometimes pallid, in one case enormously enlarged, pallid, and globular; body sometimes very faintly dotted with white above by the greater or less pallor of the hair-bearing papillae. Spines (86: 63) black, longer than the straight apical hair, a little shorter than the segments. Length, 7.5 mm.

Fourth stage. This stage does not greatly differ from the preceding, but the papillae

of the head are very large and high, taller than broad, and on the body the pale colors are more prominent and have assumed a straw-yellow color; there is a distinct macular, substigmatal yellow stripe. The apical hair is not half so long as the spine (86:64) from which it springs. Length, 12 mm.

Fifth stage (74:35). Head (78:59) bronze black, covered with large and rather frequent black or black-tipped white tubercles, and not very numerous smaller warts, all bearing rather short fuscous hairs. Colors of the body varying in a very extraordinary degree, so that it is exceedingly difficult to give any general description. I think the normal form may be described as velvety black, many of the little warts white, but a dorsal line devoid of white dots, a substigmatal band formed of longitudinal narrow open lunules of pale yellow, and on the abdominal segments an interrupted, slightly oblique, stigmatal line of confluent yellow dots; the spines (86:65) mostly or wholly black, or having the extreme bases sometimes obscure dull orange; the longest spines scarcely exceed in length one-half the greatest breadth of the head, and the apical spinule, or that portion of the main stem which lies beyond the base of the lateral spinules, is much shorter than the other part of the spine; at its base the spine is scarcely elevated; the spiniform tubercles of the first segment are moderately long and the hairs scattered over the body short and inconspicuous; spiracles black with pale lips. Legs black; prolegs pale rufo-testaceous. Length, 30 mm.; breadth of body, 5.5 mm.; breadth of head, 3.25 mm.

The white sometimes becomes a snuff color and the tint extends farther and farther from the little wart where it had its origin, until nearly or quite the whole of the animal with its spines may become light colored. But to give a better conception of the variation I add short descriptions of several stages of ornamentation. I will add that Mr. P. S. Spragne, who has reared large numbers of this insect, first called my attention to the fact that they often change their color from black to snuff color during their growth, although never the reverse. That this must be so is evident when one notices that the palest forms are never seen among specimens of the first three stages; after that, so far as my experience goes, about one-fourth or one-third of the individuals change to a saffron tint. Some specimens are entirely velvety black, with only a few pale obscure dots over the body, hardly noticeable without a lens, and the bases of some of the spines surrounded with very obscure dull orange; all the spines and spinules entirely black. In others, still black, the body is profusely dotted with white, the spines pale lemon yellow, those of the thoracic segments black, the dorsal ones of the third thoracic and first and sixth abdominal segments fuscous, the substigmatal band broken up into a series of double dots and altogether wanting on the anterior parts of the segments. Others similar to this have all the spines of the thorax black, excepting the lateral ones of the third segment, while all those of the body are yellow. Occasionally there is a short streak a little below and in advance of the laterodorsal spines of the abdomen. When the pale colors of the warts have begun to be confluent, the specimens assume a very different appearance. In some the prevailing hue is a rather pale olivaceous green, the warts of the same color but minutely centred with white, bearing white hairs and encircled in whole or in part at the extreme base with blackish fuscous; the whole upper surface begrimed more or less with delicate blackish fuscous streaks and congregated specks, excepting along a broad, pale greenish yellow, infrastigmatal band and in part along a narrow suprastigmatal band and the short streak in advance of the laterodorsal spines; the spines pale greenish yellow, their spinules mostly black, the basal ones sometimes pellucid or testaceous, all those of the infrastigmatal row testaceous. Others are of a livid hue, marked with obscure brown, most of the spines pellucid, but some infuscated, resting on pale, dull, lemon yellow warts. Still others are of a very pale straw color, tinted very slightly here and there with purplish and marked with dark, purplish slender streaks and small spots congregated linearly or distributed in irregular annular rings; the hairs white, the spines pale lemon yellow, the spinules generally black. The color has nothing to do with the sex.

Chrysalis (83:52,53,55). Wings and front ashy brown, the wrinkles fuscous, the

tongue dusky, the nervures of the wings, incisures of the joints of legs and antennae as well as the borders of the tongue and ocellar ribbon marked with blackish fuscous. ocellar prominences but little protuberant. Head above and thorax ashy brown, tinged with reddish, a slender dorsal line on the thorax; basal wing tubercles more or less blackish fuscous; supralateral thoracic tubercles a little higher than in the other species, gleaming gold; metathorax with a transverse spot of the same. Abdomen dark ashen brown, the first and second segments tinged with reddish, the whole more or less obscured with blackish fuscous, especially along a stigmatal band, which is as broad as the length of the spiracles, and also along a slightly broader and darker ventral stripe; laterodorsal tubercles of the first and second abdominal segments and supralateral wart of the third segment gleaming gold; other tubercles brownish yellow, bordered, especially anteriorly, with blackish; suprastigmatal wart of the ninth segment as prominent as the others of that series; there is a dorsal series of longitudinal oval patches of dull or bright greenish gold just behind the dorsal warts and bordered laterally with obscure, dark, fuscous spots; a suprastigmatal transversely oval patch of greenish gold on the side of the fourth segment. Spiracles dark ashen brown; cremaster blackish on ventral, ashy on dorsal surface; field of anal hooklets long and slender, three times longer than broad. Length, 20.5 mm.; breadth at ocellar prominences, 3.75 mm.; at supernumerary wing tubercle, 7.5 mm.; at tip of third abdominal segment, 6.5 mm.; height at mesothorax, 7 mm.; at middle of third abdominal segment, 7 mm.; at posterior end of thorax, 5.5 mm. The whole body is often covered with an ashen white bloom, but so far as I have noticed them such specimens have always been attacked by Tachinae. It may, however, be only an accidental coincidence.

Geographical distribution (20:7). This butterfly enjoys a very extensive geographical range, extending over nearly the whole of the European and North American continents. In the Old World, it occurs in the whole of Europe, excepting the northernmost portions, and is also found in the Caucasus, Asia Minor, on the western half of the northern coast of Africa and in the Azores. It has even been accidentally introduced into New Zealand, no doubt with plants, as it was first found in the Wellington Botanic Garden (Ent. monthly mag., xxi: 87), and into the Hawaiian Islands where it is known as a mountain species (Parker, Psyche, ii: 213).

In America it extends over the whole of the United States and adjacent regions as far north as Newfoundland (British Museum, Gosse), Nova Scotia "rare" (Jones), Anticosti and southern Labrador (Couper), Godbout River, mouth of St. Lawrence "common" (Corneau), Quebec "rare" (Bowles), Ottawa (Billings), Montreal "generally scarce" (Caulfield), London, Ontario "not very common" (Saunders), and even at Moose Factory, Hudson Bay (Weir); southern Michigan "rather common" (Harrington), Wisconsin "common" (Hoy), Iowa, not uncommon (Allen, Austin, Parker) and the North West Territory of Canada (Geddes). It is abundant in the extreme southern states,—Florida (Chapman, Palmer, Thaxter, Schwarz), Alabama "a great rarity" (Gosse), and Texas (Belfrage, Aaron, Lintner); and even occurs in Bermuda "rare" (Jones), in Cuba "excessively rare" (Gundlach), in Mexico (Sallé, Brit. Mus.), and in the highlands of Guatemala "but not

very abundant" (Godman and Salvin). On the Pacific coast it is found in Vancouver Island (Fletcher) and in central California (Agassiz, Edwards, Osten Sacken), but how far south of the last is uncertain. It has been reported from the mountainous region in the heart of the continent only from Colorado (Mead), but probably occurs wherever nettles are found.

I believe that it is found plentifully and in nearly equal numbers through every part of New England, although it is comparatively scarce in the heart of the White Mountain region where nettles are found only in old clearings. As the abundance of the species is more than ordinarily affected by the action of parasites, the records of a single year for any locality are comparatively worthless.

Haunts. The butterflies enjoy cultivated surroundings, especially gardens, and in spring are to be seen on lilac flowers, in autumn on dahlias. They frequently pitch on trees or on the ground; they suck the juice of fruit and may readily be caught about apples drying in the sun. They are never to be found except in sunny spots.

Oviposition. The eggs are laid singly (though I have several times found two and once three far apart on the same leaf) on the upper side of leaves, generally near the middle, but not infrequently on the extreme edge, never, so far as I have seen, on the ribs; once only have I seen one on the under surface and in this the leaf was curled partly over: they are not very firmly attached, perhaps owing to the numerous hairs on the leaves, but seem to cling by a corner or any part that touches any portion of the leaf or hairs, and so to rest at any angle with the surface. Leaves about the middle of the upper half of the plant or a little higher are always chosen by the butterfly; Mr. Edwards, judging from the place where the youngest larvae are found, says they are laid on the topmost leaf, where I have never found them, though I have collected a hundred. They may possibly act differently toward *Boehmeria* on which he has commonly found them, than toward nettle where only I have seen them, but it is not probable; yet the topmost leaves are far more accessible than any others in a nettle patch. They hatch in five or six days.

Food plants. The caterpillar feeds indiscriminately on every variety of nettle (*Urtica*). Mr. Edwards has also obtained it on hop (*Humulus lupulus* Linn.) and false nettle (*Boehmeria cylindrica* Willd.), and Dr. Chapman has reared it in the south on the latter plant and on *Parietaria debilis*,—all belonging to the same family, *Urticaceae*. In Europe it has been found on three species of *Urtica* and on *Parietaria*.

Habits of the caterpillar. To escape from the egg, the caterpillar bites around the summit, casts off the lid thus formed, and then generally eats from a fourth to a half of the sides of the egg in an irregular manner; he then quits the leaf on which he was born and hies him to one of

the half-opened leaves at the very summit of the plant, where he lines the upper surface of the leaf with a silken web, so fastened at different points as to draw together the approximate outside edges, thus forming a canopy within which he lives concealed, solitary and indolent. Evidently the newly born caterpillar could not effect such an operation on any other than the tenderer, newly opening leaves; and it therefore seems strange that the parent should choose leaves farther down the stalk, the duration of the egg being so short. It is this habit of the young larva which has led Mr. Edwards to state that the eggs are laid on the terminal leaves. During the first stage, the caterpillar "eats the substance of the leaf within its case, at some distance from the tip, leaving the frame-work untouched. It makes its resting place quite close to the base, and there it will remain till after it has passed the first moult. Most of the feeding is done at night" (Edwards, *Can. ent.*, xv: 15). After moulting it quits this retreat and takes possession of a lower expanded leaf. Mr. Edwards watched one of these and found that it first gnawed nearly through the midrib at the very base of the leaf and cut also a hole next the rib in the base of the leaf itself, by which the leaf was made to droop; the opposite edges of the leaf were then stitched together so as to form a canopy as before (*loc.cit.*); often it eats holes between the next pair of side veins, as in the figure (81: 6), and then the lateral rib between the holes is also weakened by gnawing. By this peculiar mode of weakening the leaf, the nest may be readily distinguished from that of *Pol. comma* on the same plant. During the early part of this stage, it feeds still within the leaf, but toward the end it devours the extremity of the leaf which serves as a nest, but no longer as a complete concealment. A new one is made after the next moult, often open more or less at both ends and it now

Begins with the extremity of the folded leaf, and eats downwards [i. e. toward the base, actually upwards], and, as it gradually consumes its habitation, it retreats backwards, till at last, having, as it were, eaten itself out of house and home, it is forced to abandon its imperfect shelter, and construct a new one. . . . The sides of the larger leaf selected for its new habitation are drawn together by silken threads, so that the edges of the leaf meet closely and form a light and commodious cavity, which securely shelters and completely conceals the included caterpillar. This in time is eaten like the first, and another is formed in like manner. (Harris, *Inj. ins.*, 3d. ed., 295.)

I have generally found that even the largest caterpillars made their nests of a single leaf (81: 2) and such has been the experience of others; but Mr. Lintner on one occasion found that "the greater number of the nearly mature larvae were hidden in a shelter made by spinning together several of the leaves at the tip of the plant, after the stalk had been partially eaten through at a suitable height, so as to permit it to be readily bent downward among the leaves beneath, where a thicker shelter could be constructed (*Ent. notes*, i: 51). I have occasionally found similar compound nests, but have not noticed the bending of the stalk. Mr. Edwards, how-

ever, records a similar case in a larva observed in the house. This is a curious instance of instinct on the part of the caterpillar, of which Mr. Edwards (*loc. cit.*) gives another: A larva just past the first moult

Was placed on one of the second pair of leaves [from the top], and it closed the edges without biting the midrib, until it had gone one-third the length of the leaf, when it returned and broke the midrib, and also ate the two holes at its base. We may suppose that the larval mind at first decided that the leaf would come together [at the edges] without the rib being broken; and second, discovered that this was a mistake, whereupon rectification was made. At all events, that is what a human architect would have done.

The duller under surface of the leaf being brought into contrast with the upper by the construction of the nest, it is rendered somewhat conspicuous; and the drooping habit induced makes it still easier to discover in a nettle patch.

Generally a large number of caterpillars may be found upon a single nettle patch or even upon one plant; but it is in no proper sense gregarious, as stated by Miss Middleton (10th Rep. ins. Ill., 86), but on the contrary strictly solitary, though instances have been known of more than one caterpillar in a nest,—undoubtedly a pure accident.

When the larva is disturbed, as for instance by the crawling of another caterpillar on the outside of the leaf, the lord of the manor signifies his disapproval and alarm by running from one part of his enclosure to another, wagging his head violently so as to strike the side of the leaf or some of the connecting threads and thus jolt off or frighten away the intruder; the blows effect quite an appreciable jarring of the leaf.

I am indebted to Miss Guild and to Messrs. Angus, Clapp, Lintner, Saunders, Sprague and Verrill for living specimens of this caterpillar.

Pupation. The caterpillar suspends itself in almost any place where it can hang, and even frequently undergoes its transformations, as Boisduval long ago observed, within the leaves that have served it for shelter. This was doubted by Mr. Edwards as he had never met with such a case, but his objections were afterwards withdrawn, on receipt of specimens from Mr. P. Laurent, who in a short time had found no less than one hundred and twenty-five chrysalids in such cases, the condition of which was such that it was evident that the caterpillars had taken their last meal from the leaf which served this double purpose. Nevertheless it is comparatively rare, more substantial supports being sought. Nor, on the plant, does it always change within its final larval nest, but sometimes forms from a single leaf a hood, like that made by the larva of *Pol. comma*, but without biting any part of the leaf, midrib or stalk, merely fastening beneath the midrib the opposite edges of the base of the leaf, spinning a web within and hanging itself within the open enclosure. When it has suspended itself in preparation for its change to chrysalis, the body of the caterpillar is curved upward so as to bring the jaws and all the

legs on a line with the second pair of prolegs. The chrysalis stage generally lasts about ten days.

Life history. Both in Europe and New England there are two broods of this insect, although some of the chrysalids of the later brood do not disclose their inmates until spring, when the hibernating butterflies and those from wintering pupae mingle on the wing and deposit their eggs, so far as known, simultaneously. The wintering imago is one of the last of hibernating butterflies to make its appearance in spring, being seldom seen before the beginning of the second week in May (though Mr. Grote says he has seen them in February on Staten Island); and since individuals emerging from wintering chrysalids often appear by the last week in the same month, always as soon as the first week in June, though still emerging until the middle of the month, battered and brilliant specimens from the same brood of chrysalids may be seen flying in company. Both apparently deposit their eggs at the same time, and the larvae may be found in various stages of development through nearly the whole of June and the first half of July; the chrysalids hang for about ten days* and the butterflies appear by the first days of July and continue to emerge from the chrysalis throughout the month; the eggs are laid at once and another brood of caterpillars may be found between the middle (or even at the end of the first week) of July and the last of August; the butterflies appear the very last of August and early in September, and fly throughout this month and even later, though in gradually diminishing numbers; they are among the last of our hibernating butterflies to seek their winter quarters, and, as stated above, some of the chrysalids of this autumn brood do not disclose the butterfly before the ensuing spring.

Mr. H. T. Stainton tells me that in England *atalanta* delays its hibernation until nearly December, and does not make its appearance again until June, which is as in New England; while on the northern shores of the Mediterranean it never hibernates, properly speaking, as the cold is never strong enough in the winter months to induce it to do so.

In our southern states there is undoubtedly some variation from this history, for there the butterfly is at least triple-brooded. Mr. Edwards says that in West Virginia "there are three broods of the larvae, the first in May and early June, the second in July and early August, the third late in September." (loc. cit.) According to Dr. Chapman's observations in Appalachicola, Fla., the wintering chrysalids disclose their butterflies toward the end of April, and the last brood of the season appears early in November, between which months there is certainly time for even more broods than two. Further south still, pretty fresh specimens, which could hardly have wintered, were obtained by Dr. Palmer at Indian River the last of March. In these warmer latitudes, as in southern

*Sepp says of this brood in Europe that it hangs for about three weeks.

France, this butterfly, loth to hibernate, flies the winter through. In Newfoundland, to judge from Gosse's observations, there is probably but a single brood.

According to Mr. F. B. Jefferys (Entom., xvii: 183), in Kansas the butterfly is most abundant in the spring and rarely seen in autumn. This would indicate a very large proportion of wintering chrysalids. In England Mr. G. D. Smith had one chrysalis disclose the imago in his breeding cage as late as November 9th (Ibid., xvii: 17).

The longevity of the butterfly is so great that specimens may be seen the whole season, and in warmer countries the whole year, through: Meyer Dür says this is occasioned through unequal development of the larvae, but the species does not seem to me to differ in this respect from many others. The hibernating butterflies pass the winter in crevices of rocks, in hollow trees and under house roofs. A letter from Mr. Hayhurst of Missouri, published by Mr. Edwards, states that "during last winter, in February, a tree was felled on the line of the railroad on which I was at work. As it fell it split open and was found to be hollow. The cavity was partly filled with dirt and hickory-nut shells, but among the stuff that fell out were some twenty butterflies, mostly *Vanessas* . . . *antiopa* and *atalanta*." Mr. A. R. Grote also once found three or four specimens hanging to the rough rafter of a garret on Staten Island, and perfectly torpid.

This butterfly is another of those which are very irregular in their abundance from year to year, and it is exceptionally subject, as we shall see, to the attacks of parasites.

Newman states that in England the butterfly has been detected wandering about in the night, and that he has repeatedly taken it at the sugar prepared for *Noctuae*; it has been observed about the electric light in this country by Mr. H. Edwards.

Flight and attitudes. The flight of this brilliant butterfly is vigorous, quick and nervous. Mr. Thos. Hill describes its action as seen by him one hot season in England (Entom., xviii: 73). "I saw it," he says, "skimming over the tops of the oak trees. . . . They darted through the air with a rapid motion, high above the tops of the trees, and then darting suddenly down to the clover flowers in the field below, they rested for a moment and then took another flight over the tops of the trees."

When resting on the ground after flight it "often alternately expands and closes its beautiful black and scarlet wings" (Gosse). When settled upon the ground, the wings are usually extended horizontally, the costal edge of the fore wings placed nearly at right angles with the body, while their inner margin reaches the middle of the lower subcostal interspace of the hind wings. They often elevate the costal edge of the fore wings slightly while the hind wings remain stationary, and then the inner margin is pushed backward over another interspace. The

antennae are straight, raised slightly above the plane of the body and spread at about a right angle. When alarmed the wings are closed back to back with a sudden start. When resting upon flowers or the leaves of a tree, the wings are generally held at or very nearly at right angles with each other. When at rest for the night, the fore wings are as nearly hidden between the closed hind wings as is possible, the costal edge of the former emerging between the tips of the costal and upper branch of the subcostal nervure of the latter; the antennae rest against the costal edges of the hind wings, their tips diverging very slightly.

Parasites. Not only does a little *Trichogramma*, *T. minutissimum*, infest the eggs of this butterfly, discovering them during their brief life, and emerging about a fortnight after the time for the caterpillar to hatch, but the caterpillar is sorely beset. First there is a species of *Apanteles*, *A. edwardsii*, which must sting the caterpillar before it has completed its very first nest, as Mr. Edwards suggests. Any one that will watch a newly hatched larva will observe its restlessness until its nest is made; Mr. Emerton had exceptional difficulty on this account in making a drawing of it, though many larvae are impatient at this stage. At any rate one may often find the pure white or silvery-gray cocoon of this insect resting beside the larval skin in the nest of the defunct caterpillar, and will find the latter is never beyond the second stage and that one parasite has been enough to kill him. Apparently these parasites sometimes winter in the cocoon. Mr. Edwards (l. c.) gives some account of the action of the species, and found it held in check by a species of *Tetrastichus*, *T. modestus*.

But although in this case a single worm is enough to destroy one caterpillar, far worse havoc is made among the nettle feeders at a later stage by another species of *Apanteles*, *A. atalantæ*. It is often difficult to procure a single butterfly from a large number of larvae taken in the open air; they are crammed full of these parasitic enemies, which suddenly emerge together through the skin of their victims when full grown, and spin their pure white cocoons beside the now collapsed prey. I first observed them when from some caterpillars of *atalanta* sent me by Mr. W. Saunders of Ontario and Mr. C. P. Whitney of New Hampshire (subsequently raised in numbers by Mr. P. S. Sprague and myself) some pale, dirty yellow, cylindrical worms, 3 mm. long and .75 mm. broad, forced their way indifferently from the back, sides or under surface of the caterpillar, and immediately began to make cocoons for themselves on the nearest spot, the caterpillar itself, and the surface on which it was resting. As the grubs which inhabit a single caterpillar penetrate its integument for their change at nearly the same time and in close proximity, their united efforts form a network of pure white floss in which the cocoons (88:13) are enclosed. Generally the mass of cocoons is double, one-half on each side of the caterpillar, which seldom stirs from its position and never far after the emergence of its foes, although

life may not become extinct for several days. At other times from some movement of the caterpillar they become merged into one mass. One such cluster was formed of regular layers of cocoons piled like so many logs upon one another, with no loss of space between them, so that they were compact and unyielding, the ends of the cocoons or sides of the mass, and especially one side, furnished with a quantity of loose, flocculent matter, together forming a well-rounded, short-oval mass, 11 mm. long, 7 mm. broad and 4 mm. high, the breadth being the direction of any one cocoon; without the flocculent matter it would have been but 5 mm. broad. The cocoons are made of thicker or more compacted silk than the rest, and all parts but the extremity where the head of the future pupa is to lie are completed first, and then this end is sealed up with a thin, nearly flat covering, easy for the jaws of the imago to sever. The cocoons are cylindrical, of uniform size, 3 mm. long and .85 mm. broad, and are not so thick as not to show the dusky color of the enclosed pupa. Even in the very regular mass I have described, the anterior extremities of the cocoons were not all placed in the same way, but directed indifferently toward either side. In the different instances in which I counted them, the cocoons from a single caterpillar varied from twenty-six to thirty-nine in number.

The grubs emerge from the caterpillars in the early part of June and appear as winged insects in about eight or ten days. A second brood emerges in the middle of July, and a third, which appears in September, remains in the cocoon all winter.

In emerging from the cocoon, the little hymenopteron, *Apanteles atalantae*, cuts away the thin circular lid and pushes it upward, where it remains entangled in the threads of the flocculent mass. The males are the least abundant; in one instance I obtained seven males and twenty-two females; in another six males and twenty-nine females. The males make their appearance first, although the whole community emerges within an hour's time, with the occasional exception of a straggler who may be detained a day or more. The moment they have cut their way out they race about with widely outstretched jaws, their antennae trembling vigorously.

To see the operation of this little parasite I placed some females two days old under a glass with caterpillars of *atalanta*, some fully grown and others about half as long. The parasites were put in first and the caterpillars introduced afterwards. There was no change in the action of the parasites at this time, no recognition of the presence of their victims, although both before and afterwards they were in constant motion, evidently in search of prey. In their blind wanderings, coming into contact with a bit of web made by a larva of *atalanta* in the angle of a nettle leaf and vainly endeavoring to penetrate it, they at once went vigorously at work to bite their way through, as if confident that the object of their

search was beyond. They did not seem to be aided at all by sight, for they frequently ran accidentally into the caterpillars when they were in their way and turned aside as soon as their antennae came into contact. The smaller caterpillars were not stung; indeed there was scarcely space between the spines to allow the parasites room to bring their short ovipositors into contact with the skin; but the larger ones were repeatedly pierced. On meeting these there was a moment's pause, then the parasite ran or jumped, as it were, upon the side of the caterpillar, flitted its wings in the air, stung it in an instant's time, and then ran off and about as before. It seemed to be indifferent as to whether the caterpillar was in motion or quiet. When the caterpillar felt the sting he started and then walked quickly away. In five or ten minutes the parasites became perfectly quiescent, although they had stung the caterpillars but a few times. Probably they had exhausted their momentary supply of eggs.

We have, besides, another hymenopterous parasite in *Microgaster carinata* (88: 11), which often crowds the body of the caterpillar full of worms, eating the nourishment it endeavors to procure for itself; and still another, a species of *Eulophus*, the coal-black chrysalids of which one may sometimes find, to the number of twenty or more, standing erect on their hinder ends around the corpse they have destroyed, like black tomb-stones in a cemetery, a most melancholy spectacle on opening a nest to get the young caterpillar.

As if these were not enough, a dipterous foe ravages what the Hymenoptera have left, in the person of *Exorista futilis* (89: 10). Mr. P. S. Sprague and myself have raised large numbers of this parasite. They sting the caterpillar and emerge as maggots either from it when fully grown, or more generally from the chrysalis, during the first seven days of its suspension. Chrysalids containing these flies may generally be distinguished by a pale ashen bloom, so far as my experience goes. The maggots change at once to pupae and become winged in less than a fortnight, or, in the examples I have seen, about the first of August. I do not know at how young a stage the caterpillars are stung, but I have had specimens in my breeding cage for a fortnight which must have been already pierced, but which showed no signs of any affection until after the suspension of the chrysalis. Usually one but sometimes two dipterous grubs come from a single specimen of *atalanta*. In escaping from the pupa case the two anterior joints are forced off as a sort of lid, not whole but broken into two equal halves, each the quarter of the periphery of a sphere.

In Europe numbers of *Microgaster deprimator* Spin., emerged early in August from the caterpillars of the butterfly I was raising, and became winged in eleven or twelve days; not more than one-sixth of them were males. Dr. Dimmock has called my attention to the statement that

Pteromalus puparum also attacks *atalanta* in Europe (Naturalist, 1886, 213), and Bignell gives a list of four Hymenoptera: an *Amblyteles*, a *Limneria* and a second *Microgaster* (*M. subcompletus*) known as parasites in England, besides *Mesochorus*, a hyperparasite on *Microgaster* (Buckler, *Larvae Brit. Butt.*, 200), and a hyperparasite *Hemiteles*; and as will be seen by the list in Mr. Howard's chapter on parasites, a *Hoplismenus* and an *Apanteles* can be added to the list of parasites in the Old World; while among the Diptera parasitic on this caterpillar in Europe Dr. Williston tells me are found a *Phorocera*, a *Mascicera* and a *Voria*.

Desiderata. We are well acquainted with the history of this butterfly, so common on two continents; yet we need further details to mark the broods with greater precision, and there is some discrepancy in the statements of the duration of the chrysalis state; perhaps this differs with the season of the year. We ought to know at about what latitudes the annual broods increase in number. Large numbers of the last brood of caterpillars should be raised, under the most natural conditions possible, to see how large a proportion of the chrysalids hibernate.

LIST OF ILLUSTRATIONS.—*VANESSA ATALANTA*.

General.

Pl. 29, fig. 7. Distribution in North America.

88: 11. *Microgaster carinata*, a parasite.

13. Cocoons of *Apanteles atalantæ*, a parasite.

89: 10. *Exorista futilis*, a dipterous parasite.

Egg.

Pl. 64, fig. 24. Colored.

Caterpillar.

Pl. 70, fig. 10. Caterpillar at birth.

74: 35. Mature caterpillar.

78: 58, 59. Front views of head in first and fifth stages.

81: 2. Nest of half grown caterpillar.

6. Base of a nettle leaf as bitten to form a nest.

86: 61-65. Dermal appendages of stages i-v.

Chrysalis.

Pl. 83, fig. 52. Side view in outline.

53. Dorsal view in outline.

55. Side view.

Imago.

Pl. 2, fig. 6. Female, both surfaces.

12: 5. Both surfaces.

33: 29, 29a. Male abdominal appendages.

61: 29. Papilla of tongue.

37. Prothoracic lobes and patagia.

GROUP II (*Neopyrameis*).

Brighter colors of the upper surface of the wings of the imago not clustered into a band, but broken into patches covering a broad belt. Under surface of hind wings with larger or smaller ocellate spots, often very perfect, in a submarginal series. Hook of upper organ single at tip. Clasps nearly equal throughout, larger than in the previous section, and the hinder edge a little angulated in the middle; secondary armature longitudinal.

VANESSA HUNTERA.—The painted beauty.

[The painted beauty (Gosse); Hunter's butterfly (Harris); Hunter's cynthly (Emmons); the marbled Cynthia (Ross); scarce painted lady (Fyles).]

Papilio huntera Fabr., Syst. entom., 499 (1775);—Panz., Drury Abbild., 39-40, pl. 5, fig. 11 (1785);—Herbst, Natursyst. ins. schmett., vii: 165-166, pl. 178, figs. 5-6; pl. 179, figs. 1-2 (1794);—Smith-Abb., Lep. ins. Ga., i: 17-18, pl. 9 (1797);—Abb., Draw. ins. Ga. Brit. mus., vi: 29, figs. 28-29; xvi: 31, tab. 109.

Vanessa huntera Gey., Hüb., Samml. exot. schmett., iii: Lep. i, Pap. i, Nymph. vi, Hamadr. A, dec. i, figs. 1-4 (1826?);—Boisd.-LeC., Léop. Amér. sept., 180-181, pl. 48, figs. 1-4 (1833).

Cynthia huntera Harr., Hitchc. Rep., 590 (1833); Ins. inj. veg., 3d ed., 292-293, fig. 119 (1862);—Kirb., Faun. bor. amer., iv: 296-297 (1837);—Westw., Drury Exot. entom., i: 10-11, pl. 5, figs. 1, 1 (1837);—Humphr.-Westw., Brit. butt., 3d ed., 57, pl. 15, figs. 5-6 (1856).

Pyrameis huntera Doubl.-Hewits., Gen. diurn. Lep., i: 205 (1849);—Morr., Syn. Lep. N. Amer., 60 (1862);—Saund., Can. ent., i: 105-

106 (1870);—Freuch. Rep. ins. Ill., vii: 153 (1878); Butt. east. U. S., 199-200 (1886);—Middl., Rep. ins. Ill., x: 86 (1881);—Coq., ibid., 153. (1881); Fern., Butt. Me., 61 (1884);—Mayn., Butt. N. E., 19, pl. 3, figs. 21, 21a (1886).

Vanessa hunteri Hüb., Verz. schmett., 33 (1816).

Papilio belladonna dicta virginiana etc., Pet., Gazoph., i: 4, pl. 33, fig. 5 (1709).

Nymphalis gem. cardui virginienensis Drury, Ill. nat. hist., i: 10-11, pl. 5, fig. 1 (1770).

Pyrameis virginienensis Kirb., Syn. catal. Lep., 186 (1871).

Papilio iole Cram., Pap. exot., i: 17-18, pl. 12, figs. E. F. (1779).

Vanessa terpsichore Phil., Anal. univ. Chile, xvi: 1089 (1859).

Pyrameis terpsichore Reed, Anal. univ. Chile, xlix: 679, pl. 2, fig. 1 (1877).

Figured by Glover, Ill. N. A. Lep., pl. 14, fig. 9; pl. 33, fig. 2, ined.

On the rock, they scorch
Like a drop of fire
From a brandished torch.
Fell two red fans of a butterfly:
No turf, no rock, in their ugly stead.
See, wonderful blue and red.

BROWNING.—*Dramatis personae.*

Imago (2:2, 3; 12:9). Head covered with dark vinous or mouse-colored hairs, mingled, especially toward the rear and down that portion of the front which is concealed by the palpi, with a few delicate, pale hairs; hinder edge of the eye broadly bordered with white scales, narrowing above and backed by dark green, metallic scales. Palpi white, the upper surface and the uppermost edges of the sides dark brown, the long hairs of the sides blackish, those of the upper surface tinged with reddish. Under surface of antennae brownish luteous, the remainder blackish brown with scattered, whitish scales, most abundant on the sides and especially on the outer side; club pale orange luteous, the basal two-thirds covered above with blackish brown scales.

Prothorax covered with hairs, colored like those of the top of the head. Thorax covered above with dark metallic green scales, concealed by olivaceous brown and golden hairs; patagia slightly reddish brown with a few scattered, pale hairs; beneath covered with grayish white hairs which are often reddish brown at base. Fore tibiae dark brown in front, broadly bordered with long, whitish hairs. Hind femora covered with dirty, silvery white scales, excepting the middle of the apical portion of the upper surface of the middle pair and along the middle of the inner surface of the hind pair, where they are mulberry brown. Tibiae and tarsi dirty white, specked with pale brown, the under surface of the latter dark yellowish brown: spurs testaceous, spines black; claws reddish brown, darkest at tip.

Outer border of *fore wings* (38:12) strongly sinuate, the upper portion broadly rounded, its lower angle well rounded, the lower portion considerably bowed. Third superior subcostal nervule arising at about one-third, and the fourth at a little less than three-fifths the distance from the origin of the second to the outer border.

Color above fuliginous black with a slight purplish tinge, the nervules black, the basal two-fifths of the costal margin, the basal two-fifths of the cell and a corresponding portion of the base of the wing beneath the median nervure heavily flecked with greenish golden scales; the remainder of the cell and the rest of the wing beneath the median nervure, excepting the apical half or more of the upper median interspace, and the outer margin of the other interspaces to the depth of three-quarters of an interspace's width, golden orange, deepest in tint in the neighborhood of the black. It is, however, infringed upon by a number of irregular blotches, viz., in the cell a moderately broad, transverse, quadrate spot, usually rounded below, depending from the subcostal nervure, crossing the upper two-thirds of the cell in the middle of the outer two-thirds of the same, barely separated exteriorly from a subtriangular elongated spot, which extends upward nearly or quite across the whole of the cell from the median nervure: just beyond the basal flecking in the upper half of the cell is a minute black spot free from orange scales, and the outer margin of the cell is narrowly edged with black; an irregular, slender, widening stripe crosses the outer portion of the orange field; in the upper median interspace it is a slender line, situated just where the interspace begins to narrow; below it is broader and widens a little at the nervures, crossing the lower median interspace at right angles, removed a little inward from a direct continuation of the previous part of the belt, and the medio-submedian as a curved or bent stripe, its lower part further removed from the base of the wing than its upper, and its upper extremity removed a little outward from direct continuity with the preceding portion; besides these there is only the base of the lower submedian interspace, which is black as far as the second divarication of the nervure; and the medio-submedian interspace just below the first divarication of the median, where the flecked portion of the base of the wing is edged with a narrower or wider band of black. A very little beyond the cell, in the subcosto-median interspace, there sometimes occurs a usually slender, sometimes broad triangle, directed upward from the median nervure, of pale orange, leaving the lower portion of the outer margin of the cell bordered exteriorly and interiorly with black. Crossing the upper portion of the wing, or a little more than one-third the distance from the tip of the cell to the outer border, is a transverse band of white (♂) or orange, generally pale next the costal margin (♀), its interior border well defined, nearly straight, a little concave, reaching from the costal border, or close to it, to the median nervure, the exterior border not so distinct, more curved, so that the band, otherwise nearly uniform throughout, tapers to a point below; nearer the outer margin than the band is a series of irregular white spots, the upper two close to the margin, confluent, together sublunate, bordered exteriorly with deeper black; the next two, in the lower subcostal interspaces, roundish, the lower one half the size of the upper, distant from the outer margin by the width of two interspaces, bordered interiorly with deeper black; the fifth roundish or acorn-shaped, largest, crossing the whole of the subcosto-median interspace, as far from the excised margin as the previous; there is also a sixth minute, roundish spot, sometimes obsolete, in the middle of the outer orange field of the lower median interspace. Distant from the outer margin by the width of an interspace on the upper half of the wing, and of half an interspace on the lower half, is an interrupted series of scarcely curved, inward opening lunules, of pale lavender scales above the lowest subcostal nervule, of pale mingled with brownish scales on the next two interspaces and of obscure fuscous below; the extreme margin is edged with black and followed by a few scales similar to those of the submarginal lunules and most distinct above. Fringe blackish, darkest exteriorly, mingled with or interrupted by silvery white in the middle of the interspaces, especially the median ones. Outer border of *hind wings* pretty strongly rounded, the middle half to a less extent, distinctly but not conspicuously. Precostal nervure scarcely forked at the tip. Color golden orange more or less faintly beclouded with fuscous, principally owing to the diaphanous nature of the wing; veins of the same color, flecked in outer fourth of the wing with blackish; at the base largely begrimed by an admixture of blackish scales, the inner margin griseous; extreme edge of outer margin bordered with black, as in the fore wings; a submar-

ginal black line crosses the whole wing at less than half an interspace's distance from the outer border; it broadens into spots at the nervures, which at the same point are connected with similar spots at the border; this is conspicuous only in the middle of the wing; below and especially above, the whole outer margin is obscure dark fuscous, with this thread of black passing through it; this black line is followed interiorly, at least in the middle half of the wing, by narrow, orange lunules opening inward, and these by a transverse band of similar, slightly larger, connected, black lunules, crossing the whole wing, containing, in the medio-submedian interspace, in its outer half, a transverse streak of pale bluish atoms, and in the costo-subcostal interspace, extending broadly toward the base, as far as the middle of the upper subcostal nervule and here curving around to form an obscure, sometimes almost obsolete, transverse, cloudy fuscous streak (developed to excess in the specimen from which our illustration of the male was taken), which crosses to the lower median nervule again, subparallel to the outer border but bent a little outward in the middle of the wing; within the space thus enclosed and distant from the outer margin by about the width of two interspaces is a series of five round black spots of varying size, the first in the upper subcostal interspace, sometimes obsolete, the second largest, occupying the whole width of the interspace, the fifth, in the lower median interspace, scarcely smaller, the third and fourth nearly equal and ordinarily not a quarter the size of the larger ones, the second and fifth with pale bluish pupils, the whole sometimes merged into a connected band in which the circular character of the spots is nearly lost. Fringe silvery white in the interspaces, blackish at the nervure tips, either predominating.

Beneath: the portion of the *fore wings* occupied by orange varies from pale pink to salmon color and is traversed by the same bars and stripes as above; in the cell its exterior and upper limits are more or less broadly margined with white, but otherwise it covers the same field as above. The basal two-fifths of the costal border is white, the space between the nervules crossed by numerous slender streaks of black scales, mingled with many colored scales of all hues, the stripes occupying the larger part of the space; the base of the cell is occupied by a garnet red spot in a grayish nacreous field, bordered exteriorly with whitish and followed by a black bar in which many reddish scales are mingled; base of the medio-submedian interspace pale dull purplish, followed by white and black bands as in the cell, but by much broader ones. The triangular transverse band depending from the costal border of the upper surface beyond the cell is present below as a similar white band, and the space between it and the cell, above the median nervure, is traversed near the middle by a slender streak of whitish scales, terminating below in a small, pinkish triangle; next the exterior margin of this field it is also traversed by a slender thread of white, a pale continuation of the black transverse band which traverses the roseate patch below, and the veins crossing the field are whitish instead of brown as in the other parts of the wing. Beyond the triangular white band, the wing is mainly fuliginous with an olivaceous tinge. The white spots of the upper surface are completely changed in character and the upper four are immediately followed interiorly by a moderately broad, partially obscure, white band; the upper spot is black, acorn-shaped, its base or interior edge flecked lightly with bright blue atoms, the other side edged with a deep, slender lunule of greenish yellow, edged with dark olivaceous; the second, of similar shape, is dark, garnet red, situated in a dark olivaceous field and bordered interiorly like the first, mingled with a few black scales; the third is similar to that of the upper surface, and white in a dark olivaceous field, but followed interiorly by a curved lunule of bright blue scales, which is succeeded at a little distance and bordering the whitish band, by a curved, transverse, slender, black line, edged exteriorly, on its concave surface with greenish yellow; the fourth is a pretty large, obscure, partially obsolete, velvety black spot, having exteriorly a point of white and its upper outer half much flecked with mingled metallic green, blue and olivaceous scales, surrounded at a little distance by a slender black ring, edged inside with greenish yellow and barely contained within the lateral limits of the interspace; the fifth is similar to that of the upper surface, white, exteriorly edged narrowly with dark brown; the sixth is much

larger than above, roundish, one-third the width of the interspace. At the distance of about an interspace and a half from the upper half of the outer border and at less than an interspace from the lower half of the same, is a series of curving stripes, parallel to the outer border, which vary in character; in the upper two interspaces they are slender, white lunules; in the next four, slender stripes or lunules or double lunules, blue—the lower one sometimes more or less fuliginous—edged on either side with a delicate brownish line, the upper one bordered also on either side with white; below this they are pretty large, slightly curving lunules of blackish brown; beyond this the wing is slate gray above, sometimes with a bluish tinge, as far as the lower subcostal nervule, which is tipped with a large blackish spot; and below this the border is very pale dull greenish, sometimes slightly nacreous, with a blackish thread, slightly thickened and sometimes incurved at the nervules, running through the middle; the border is very narrowly edged with black; fringe white, interrupted pretty broadly with black at the nervule tips, excepting at the base. *Hind wings* brownish fuliginous sometimes with an olivaceous tinge, the veins white, excepting where they cross the ocellate spots near the outer border. A distinct, nearly straight, slender, white stripe crosses the base of the wing from a little within the middle of the basal two-thirds of the costal margin, which as far as this is edged with white, to the median nervure, half way from its base to its first divarication; within this band, with the exception of a similar white stripe, subparallel to it at the extreme base, the wing is garnet red, specked with black and white scales. Crossing nearly or quite the whole of the cell, between the first divarication of the subcostal nervure and a little within that of the median nervure, is a large, oval, transverse spot of the same color, narrowly edged with white. Crossing the middle of the wing is a broad, irregular, white band, made grayish by black flecking and slightly tinged with yellowish, excepting a narrow interior and broader exterior uniform border, and enclosing at the base of the submarginal interspaces, between its own narrow internal white edging and a line drawn from just within the second divarication of the median nervure to the upper subcostal nervule, subparallel to the outer border, a large triangular blackish patch, mingled with olivaceo-fuliginous scales and traversed by the white veins; the interior border of this band starts from about the middle of the costal margin and with a slight curve in the first half of its course runs to the base of the first subcostal nervule; it crosses the cell close to and parallel with its outer limits; the lower median interspace a little within the second divarication of the median nervure; the medio-submedian as a band nearly in continuation with the last; is then bent inwards nearly at a right angle, and afterwards crosses from the internal nervure to the inner margin at right angles to the latter, far toward the base; the exterior margin of the band forms, as far as the median nervure, a succession of slight curves, following a general shallow curve, opening outward, from the costal margin, where the band is as broad as the smaller ocellus, to the upper median nervule, about midway between the oval spot in the cell and the outer margin; from here it follows another series of similar curves, which combine to form another large but deeper one, arching the larger ocellus and reaching the middle of the lower half of the medio-submedian interspace at about one and a half interspace's distance from the outer border; here it rounds off and turns upward at less than a right angle and strikes the inner margin at its change of curve; next this mesial band, there is a line of blackish scales, separated from the white by a feeble fuliginous line. Occupying a little more than the width of an interspace, there is, in the lower subcostal and lower median interspaces, nearer the mesial band than the outer margin, a large, circular, eye like spot; that in the median interspace half as large again as the other, consisting, first, of a central, circular, dark fuliginous or dull metallic green disc, of half the width of the interspace, narrowly edged with blue, supplanted interiorly by white, followed by a broad annulus of dark olivaceo-fuliginous, edged narrowly with greenish yellow, usually first filling the width of the interspace,—and all heavily bordered with velvety black; in the subcostal spot, the central disc is as large as in the other, but consists of a mixture of purplish black, metallic green and blue scales, of which the former predominate below, and the latter above,

followed by a moderately broad annulus of dark olivaceo-fuliginous, the remainder as in the other spot. In the middle of the upper subcostal and of the subcosto-median interspaces, midway between the exterior margin of the mesial band and the outer border of the wing is a minute, cloudy, white spot, often obsolete, that in the former interspace usually the larger; the outer margin to the width of about an interspace is dull white often tinged slightly with bluish, but is traversed, next its interior border, by a subcontinuous series of pale blue, transverse, narrow, curved bands, narrowly edged, exteriorly and interiorly, with black, and midway between this and the outer border by a slender continuous black thread, slightly thickened at the nervures: outer margin narrowly edged with black; fringe as on fore wings.

Abdomen above purplish black, heavily flecked, especially on the sides and on the apical half of the segments, with yellowish fulvous scales; beneath white. Appendages of male (33:22): upper organ moderately large, body compressed above and arched as in *atalanta*, together with the hook perfectly straight above. Hook slightly shorter than the body, depressed, two and one-half times longer than broad, tapering until near the tip which is bluntly pointed. Inferior arms nearly straight except in their first approach to each other, moderately stout, tapering pretty regularly to a point which is minutely hooked. Clasp nearly twice as long as broad, slightly broader between the upper and lower posterior angles than elsewhere, the inferior edge strongly recurved, the posterior edge produced to a right angle in the middle, the angle pointed and incurved, the upper hinder angle considerably produced and broadly rounded. Interior finger (ribbon) with the basal half as in *atalanta*, beyond delicately tapering to a fine point, sinuous, incurved and directed a little upward, scarcely attaining the tip of the backward extension of the clasp. In addition, originating in the centre of the interior of the clasp, is a lamellate, moderately broad, horizontal ridge, directed backward and equal for a short distance, then becoming free, curving inward and narrowing to a delicate point beside the interior finger.

Measurements in millimetres. Length of tongue, 13.25.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	23.	26.5	29.	27.	30.	33.5
antennae	13.3	15.	16.5	14.	15.25	17.
hind tibiae and tarsi..	8.8	10.	10.5	9.1	10.	11.
fore tibiae and tarsi..	4.5	5.25	5.75	4.5	4.5	5.

Described from 10 ♂ 16 ♀ specimens.

Egg. Short ovate, broadest in the middle of the lower half, the base broadly rounded, scarcely flattened, the contour of the summit beneath the ribs slightly convex. Ribs varying from thirteen to sixteen in number, laminate, extending from the upper portion of the rounded base to the crown of the egg, increasing in height from below upward, most rapidly above, where they are .05 mm. in height, though only .0125 mm. high in the middle of the egg. The surface between the ribs smooth, glistening, slightly concave, traversed by delicate cross lines .025 mm. apart, which traverse also the vertical ribs, where, on the upper portion of the egg, they turn upward and at the crest cause the ribs to become very distinctly serrate, especially above, but giving them a beaded appearance throughout. The vertical ribs terminate on the crown abruptly, leaving a free space .18 mm. in diameter, in the middle of which in a saucer-shaped depression is situated the micropyle .1 mm. in diameter, formed of about a dozen pentagonal cells growing very gradually smaller toward the centre, the average of the cells being .008 mm. in diameter. Color delicate yellowish green, ribs pellucid. Height of egg, .58 mm.; breadth, .53 mm.

Caterpillar. *First stage.* Head (78:52) black; body vinous brown, with a yellow tinge, blotched transversely with livid. Legs brown, prolegs the color of the body. Hairs strongly curved, blackish, situated on papillae scarcely higher than broad, rather shorter than the width of the body at maturity. Length, 2.5 mm.; breadth, .3 mm.; breadth of head, .4 mm.

Second stage. Head (78:53) piceous with black hairs; body dark brownish fuscous,

slightly paler on the last two or three abdominal segments, and, especially above, transversely and obscurely marked with pallid brown. Spinules brownish fuscous, darkest at tip; the apical hairs black and strongly curved. No signs whatever of any laterodorsal white spots on any of the abdominal segments. Prolegs and fleshy parts of the legs of the color of the body, apical joints of the legs blackish fuscous, becoming black at tip. Length, 3.5 mm.; width of head, .6 mm.

Third stage. Head black, provided with long, black hairs; mouth parts blackish. Body black or reddish fuscous, crossed transversely by many fine, broken, whitish lines which principally form two transverse stripes in the hinder half of each segment. Infra-stigmatal fold brownish yellow. On the anterior half of each segment, in front of the laterodorsal spines of the second to eighth abdominal segments, there is a white spot as large as the bases of the elevations on which the spines are seated. Spines black throughout, excepting at the extreme base, where, with a part at least of the elevations on which they are seated, they are generally dull orange. Legs black, Prolegs brownish fuscous. Length of body, 8 mm.; breadth of body, 1.25 mm.; length of spines, .38 mm.

Fourth stage. Head piceous, scarcely differing from the previous stage. Body velvety black. The principal spines encircled at their base with orange-ferruginous and the posterior half of all the segments traversed by four more or less broken, transverse, slender, white lines, the interspaces between them being of equal width with these lines. The laterodorsal spines of the abdominal segments, excepting the first, are bordered in front by a round or transversely oval, conspicuous, white spot. A pair of large papillae on the side of the first thoracic segment with one on the side of each of the other thoracic segments amber yellow, furnished with black bristles, similar to those which adorn the piceous spines of the rest of the body. The last two abdominal segments with a number of small, white papillae bearing white hairs. Other hairs of the body black. Legs piceous. Prolegs blackish fuscous. Spiracles in the centre livid white; the lips black surrounded by a white aureole. Length, 12 mm.; width of head, 1.75 mm.

Last stage (74:34). Head (78:60) varying from bronze black to shining piceous, the larger tubercles small and infrequent, yellow or black, the smaller warts not very numerous, yellow or black, bearing short black or yellow hairs, above a little longer. Antennae with the first joint obscure, pale, the rest blackish fuscous, annulated at the base of the joints with pale; ocelli black; mouth parts blackish. Body rich, velvety black, broadly banded at the interstices of the segments with transverse, alternating, slightly irregular lines of black and pale greenish, straw yellow, or with alternate, broad, transverse, equal bands of black and greenish yellow, streaked with black, the former crossing the middle of the segment from spiracle to spiracle; the space between the black bands is greenish yellow (the yellow more conspicuous on the thoracic segments) streaked transversely with four or five generally continuous but rather irregular equidistant lines of dark, purplish black; the first thoracic segment has no broad, black band; on the abdominal segments, touching the anterior base of the laterodorsal spines and the anterior border of the black band, is a row of roundish, silvery white spots, that on the first segment, or first two segments, sometimes minute or smaller than the others, the others large and equal; behind the black band of the eighth abdominal segment there is a large, transverse, dorsal, dirty white spot, from the outer extremity of which run two similarly colored slightly converging lines nearly to the tip of the body. There is a narrow, interrupted, rufo-fuscous, infra-stigmatal band, frequently obscured by paler markings, and just beneath it a row of short, longitudinal, dull orange stripes, situated on the anterior halves of the segments; beneath greenish yellow, profusely streaked and blotched, longitudinally on the sides, irregularly ventrally, with dark purplish black. Body covered with short and inconspicuous black hairs, those not on the central black band arranged to some extent in transverse rows; the spiniform tubercles of the first thoracic segment are very long and pale amber yellow, brownish or blackish fuscous; the sides of the other thoracic segments have frequent pale papilliform warts, giving rise each to a delicate blackish hair. The spines are very long, the longest nearly equalling in length the entire width of the head, the apical spinule, or that portion of

the main stem which lies beyond the base of the lateral spinules, much shorter than the other part of the spine; the spines are metallic blue black or bronze black, tinged with paler colors beyond the base, often dull, dirty, dark pellucid, those on the sides and especially on the anterior part of the body frequently yellowish, the infrastigmatal ones greenish at the base; they are mounted on greatly raised elevations, of an inconspicuous dark rufo-fuscon color. Spiracles blackish fuscon, with obscurely pale lips, rimmed with black and surrounded slightly with greenish yellow. Legs shining black; prolegs at base like the under surface of the body, beyond bronze black, tipped with pale purplish. Length, 35 mm.: breadth of body, 5.5 mm.; length of spines, 3.5 mm.; breadth of head, 4.25 mm.; length of hairs on body, .5 mm.

Some individuals have the black almost entirely superseded by ferruginous, the color having extended from the protuberant elevations at the base of the spines over the surrounding parts, so as to leave the black in only a series of dorsal spots; in these individuals the yellow of the other bands is not of so lively a hue, and the spines are pellucid blackish fuscon throughout.

Chrysalis (83: 54, 63, 64). Dull grayish white marked with grayish brown, having an olivaceous tinge, or bright golden green tinged with reddish yellow and marked with brownish purple; ocellar prominences bluntly conical. Front of the head, tongue and edges of the legs toward the head of the darker color; the other appendages, with the wings, of the lighter; the antennae interrupted with black and black at the tip, the middle of the wings with an irregular waved streak and a submarginal row of dots of the darker color; thorax and abdomen of the lighter color with darker markings as follows: The anterior part of the thorax in front of a line connecting the mesonotal dorsal tubercle and the basal wing tubercle (and excepting a widening streak of the lighter color) passing from near the tip of the ocellar prominences to the middle of the dorsal ridge of the mesonotum; a broad band passing along the side of the body from the lateral surface of the ocellar prominences, next the superior edge of the wing over the abdomen, where it includes the spiracles at its upper edge, to the base of the cremaster; lateroventral, ventral, and broken lateral bands on the abdomen. Abdomen dotted minutely and sparsely with black, especially along the posterior borders of the segments; tubercles tipped with orange; suprastigmatal wart of the ninth abdominal segment nearly or quite obsolete; field of anal hooklets scarcely longer than broad.

	<i>1st. spec.</i> <i>2d. spec.</i>			<i>1st. spec.</i> <i>2d. spec.</i>	
Length.....	19.	22.	Breadth at third abdominal segment...	5.25	6.75
Length of cremaster	1.75	1.5	Height at mesonotal tubercle.....	6.	6.3
Breadth at ocellar prominences.....	3.5	4.	Height at metathorax	5.25	5.7
Breadth at basal wing tubercles	6.25	7.	Height at posterior edge of third abdominal segment.....	6.	7.
Breadth at supernumerary tubercles.	6.5	7.75			

Geographical distribution (20:8). This, the only purely American species of *Vanessa* in New England, is apparently found throughout the entire extent of the United States, excepting Alaska and possibly a portion of the central mountainous district, where it has only been reported from Colorado, New Mexico, Arizona and the vicinity of Truckee, Nevada (McGlashan). It is common in all the Gulf and Atlantic States and has been brought from as far south as Indian River in Florida (Palmer). On the Pacific coast it is found in California, and at Vancouver Island (Fletcher). To the north, ignoring boundary lines, it has been taken in Nova Scotia "quite abundant some seasons" (Jones), Godbout River, Gulf of St.

Lawrence "rare" (Corneau). Quebec "not uncommon" (Bowles). Montreal "abundant" (D'Urban). "generally scarce" (Caulfield). Ottawa (Billings). London, Ont. (Saunders). South Michigan "rare" (Harrington). Sault St. Marie "rare" (Bethune). Nepigon. Lake Superior (Scudder). Minnesota (Scudder) and Iowa (Austin. Allen. Parker, Osborn): Mr. Lintner has taken it on the summit of Mt. Marcy in the Adirondacks. It is probably confined mainly to the Alleghanian and Carolinian faunas.

Such seems to be the meaning of its distribution in New England. It is far more common in the southern than in the northern portions and is wholly wanting in the White Mountain district, although occurring so far north as the mouth of the St. Lawrence and above Lake Superior. It was not noticed by Gosse in Compton, P. Q., or in Newfoundland, and the northernmost localities in New England from which it has been brought to my notice are Waterville "very few" (Hamlin). Norway (Smith). Hallowell "very uncommon" (Miss Wadsworth) and Mt. Desert Island, Me. (Scudder). and Milford, N. H. "scarce" (Whitney).

It occurs, however, beyond the limits of the United States and in an unusually irregular manner. Its presence far down the Florida peninsula accounts for its "very rare" appearance in Cuba (Gundlach) and it is not known from any other of the West Indian islands.* Its abundance on our southwestern borders explains why it is everywhere common in Mexico and Lower California, and occurs plentifully as far south as the elevated plateaus of Guatemala (Van Patten); it is even reported from Costa Rica by Distant, and from Panama, Colombia, and Bolivia (Godman and Salvin). But the interesting thing is that, according to Berg, an excellent authority, the South Chilean *V. terpsichore*, which extends also into Patagonia, is identical with our species, though there is no evidence that it is found on the flanks of the Cordilleras in the vast intervening region. Still more strange, however, is the report by Blackburn in 1879 that it was established on the Hawaiian Islands, and the repeated accounts of its discovery in Great Britain (never on the continent) and even on the Canary Islands: some of these British reports are erroneous, the specimen, when examined by a competent authority, being found to be an aberrant or suffused example of *V. cardui*. The earliest example, taken in 1828 in Pembrokeshire, was announced by Dale in 1830 and figured long after by Westwood and Humphreys and by Morris; in 1876 two specimens are recorded, both taken in southern maritime counties, one in Hampshire, the other in Devon (Entom., 1876, 255; Ent. monthl. mag., xiii: 183).

Oviposition. The eggs are laid singly on the upper surface of the

*Godman and Salvin (Biologia centr. amer.) give it from Jamaica and Hayti, but they do not mention seeing specimens from there.

leaves of the food plant of the caterpillar, much after the fashion of those of the other species of the genus, sometimes being laid upright, quite as frequently in an inclined position, but always very carefully tucked under the flossy hairs which cover the surface of the leaves of *Gnaphalium*, so that the egg is very nearly concealed under a thick mat of hairs.

Food plants. The caterpillars of this species feed almost exclusively on *Gnaphalieae* (a subdivision of the tribe *Inuloideae* belonging to the great family of *Compositae*), a group of plants somewhat allied to thistle. They have been found on several species of cudweed and everlasting, such as *Gnaphalium polycephalum* Michx. (Abbot, Saunders, Emery), and *G. purpureum* Linn. (Chapman, Boisd.-LeConte), *Antennaria plantaginifolia* Hook. (Riley) and *Anaphalis margaritacea* (Fletcher, Scudder). Abbot records them from the sunflower (*Helianthus*), another composite plant. Mr. Riley has also taken them on *Senecio cineraria*, and they are found plentifully on the mouse ear (*Myosotis*), a genus of *Borraginaceae* (Guild, Kirtland). Harris states (*Inj. ins.*, 3d ed., 293) that "the caterpillars are found on the same plants as those of the thistle butterfly [*cardui*], and particularly on the burdock and cotton thistle." Miss Middleton, evidently copying this statement, repeats it in a more definite form with a long list of plants (*Rep. ins. Ill.*, x: 86). Harris remarks, however, that "the larvae are very much like those of the preceding species" [*cardui*], which is scarcely true; and since he has left no memoranda of having bred them and no other observer records them from these plants, the statement certainly needs confirmation. Emmons says that they feed upon the balsam, by which he doubtless means a species of *Populus*, but this seems wholly improbable. Miss Murtfeldt found them on *Artemisia ludoviciana* in Missouri, but as they could not be carried to maturity on this plant whether out of doors or in, she regarded it as a case of mistaken instinct, the parent being "misled by the surface resemblance of the white cottony leaves of the *Artemisia* to those of the accustomed food plant of her young [there *Antennaria*], and under this misapprehension deposited her eggs in utter disregard of the somewhat pungent odor which a keen sense of smell would have perceived." (*Am. nat.*, xvii: 196.) It should be remembered, however, that *Artemisia* is not distantly related to either *Antennaria* or *Gnaphalium*, that *cardui* feeds on *Artemisia* in Ceylon, and that some species of *Gnaphalium* have a very aromatic odor. Mr. Fletcher also tells me that he has taken it on two white pubescent cultivated species of *Artemisia*.

Habits of the caterpillar. The caterpillars construct nests made after the manner of the preceding species, but which have a more dense covering throughout life; taking advantage of the silken hairs which profusely cover the surface of the leaf on which they are born, they burrow beneath them, bite them off at the base, and from these and a profuse web of their

own, the young caterpillar, not a day out of the egg, constructs a dense white mat, beneath which upon the clean surface of the leaf it takes up its abode. This mat resembles closely in the spring the central unfolded leaves of the *Gnaphalium* and also the silken cocoons of the lesser ichneumon flies, and is so dense that not the slightest view of the interior can be gained. Beneath this the caterpillar devours the parenchyma of the leaf through to the under pellicle, and when it has devoured all that it can reach it constructs a new nest, this time usually by folding together to a greater or less extent two adjoining leaves, and thereafter makes not infrequent changes of abode, probably quite as many in the course of its life as its changes of skin, though they do not appear to be coincident in any way with ecdysis. When the plants are still young and scarcely elevated above the ground, the half grown caterpillar will sometimes construct a nest beneath the leaves and in part directly upon the ground. So far as I have observed, they do not then leave their nests for food, but feed apparently only upon the portions enclosed within their web. In the autumn, when the flowers of everlasting are fairly opened, they almost invariably enclose them within their web, and pick these blossoms to pieces until, as Mr. Emery writes me, "they resemble cotton, apparently devouring the centre or kernel and making a nest with the husks connected by a slight web (81:11). This gives the naturally flat summit of the plant a rounded appearance. Only one is found on a plant." Mr. Saunders says (*Can. ent.*, i: 105-106) of one of these caterpillars, "It had drawn the leaves together and fastened them into a rude case with silken threads. The larva during its growth had consumed portions of the inner surface of the leaves, especially near their summit, and hence, here the foliage was crisp and blanched. These whitened portions of the leaves, together with the size of the case occupied by the larva when full grown, enables the collector readily to discover their places of retreat." Mr. Riley also writes me that the larva "feeds on the parenchyma, leaving the glistening white leaf-membrane untouched"; and this I have myself observed even in the full grown caterpillar, which feeds outside its web as well as beneath it; though in the last two or three days of its life it devours the whole thickness of the leaf, and cares far less for concealment, though never so conspicuous and gaily colored as now.

The excrement of the full grown caterpillar is very large, forming rude cylindrical pellets 2.25 mm. in diameter and 3.5 mm. long when dry. The caterpillar grows rapidly at first, but more slowly than usual afterwards. Mr. F. H. Sprague calls my attention to the curious fact that the very young caterpillars often assume a sphinx-like attitude. I am indebted to Miss Guild and to Messrs. Saunders, Emery, Stebbins, F. H. Sprague, Beadle and others for living specimens of this insect in its earlier stages.

Pupation. Apparently the caterpillar often undergoes its final changes in the enclosure which has last served it as a refuge; a nearly mature caterpillar, placed in a large tin box with a head of everlasting, made below and in the head an open sort of cocoon (83:64) to take the place of the nest of which it had been robbed, spinning an excessively open web, the irregular meshes of which were often a centimeter, generally 5-7 mm. in diameter, and the cavity itself about as large as a pigeon's egg, and finally transformed therein. When disturbed it swung itself with such violence as to strike both sides of its enclosure.

Life history. In New England there are two broods of this insect; the butterflies and occasionally the chrysalids of the autumn brood hibernate; the hibernating butterflies appear in the spring about the middle of May; the wintering chrysalids disclose their butterflies about the 7th or 10th of June, and these continue on the wing until the next brood appears; they lay their eggs during the first three weeks of June, and the caterpillars are fully grown between the 25th of June and the 20th of July. The chrysalis state lasts at least ten or twelve days, probably longer, for there is no record of butterflies from eggs of the same year before the middle of July; they continue to emerge from the chrysalis until about the 5th of August, and, as before, fly until the next brood appears; their eggs are probably not deposited before August, in the latter as well as the early part of the month. The caterpillars may be found throughout most of August and September, the chrysalids throughout September; butterflies of the second brood rarely appear before the 10th of September, become abundant by the 20th, and during the latter part of the month are more numerous than at any other time in the year; they continue to emerge from the chrysalis until nearly the middle of October, and some are found on the wing throughout that month, after which they hibernate, some of the chrysalids still unchanged. This last brood is always the most abundant.

In the extreme south there are apparently four broods. Whether the butterfly strictly hibernates there or not is uncertain; but it undoubtedly passes the winter in the imago state, as single specimens were seen by Dr. Chapman in Florida all through February and March. According to Abbot's observations, the earliest caterpillars are fully grown by the 7th of April, and after passing from seven to twelve days in the chrysalis state, emerge as butterflies between the 17th of April and the 16th of May; the second brood of butterflies appears by the 22d of June (Abbot) and is common by the 1st of July (Gosse); records are wanting for the hotter months, but it is certain from Dr. Chapman's notes that a brood (apparently the most numerous of the year) makes its appearance in October, and continues on the wing until the end of November (or until the next spring?). There must, therefore, be another generation in

midsummer, between the July and October broods, which probably appears near the middle of August.

Habits, flight, etc. The habits and flight of this butterfly closely resemble those of *V. cardui*, but, although considerably more abundant in some years than in others, it is much less subject to variation in this respect. It selects the same resorts and is likewise very fond of thistle-flowers, as also of dandelion-flowers; it has also a nearly equal activity and will keep on the wing to as late an hour of the day.

When at rest but on the *qui vive*, the wings are widely expanded, raised at an angle of about 15° – 20° with the surface of rest; the antennae are perfectly straight, raised above the plane of the body at an angle of 20° – 25° , and spread at nearly or quite a right angle. When quietly resting, the wings are placed back to back, and the antennae, raised at an angle of 40° with the body, are spread at an angle of only 50° . It, however, frequently varies from this by gently fanning its wings upward and downward in a self-contented way, about once a second. When, however, the insect is at complete rest, as during the night, the wings are not only closely compressed, but the fore wings are hidden by the hinder pair so that the costal edges of both are continuous, while the antennae are nearly perpendicular, placed at right angles with the body, and spread about 12° . Dr. C. S. Minot also observed, many years ago, the position of the legs when at rest. The middle and hind femora are nearly at right angles with each other, and when on a horizontal surface the whole of the tarsi rest on the ground; when on a perpendicular support, it touches only the claws to the surface of support. He also observed it clean its antennae by folding the tarsi at a sharp angle and drawing the antennae from base to apex through the crotch thus formed. This is the more remarkable because done with the middle legs.

Parasites. The caterpillar is attacked by a large ichneumon, *I. rufiventris* (88:1), which finally makes its escape from the chrysalis at the end of September. The ichneumon is so large that the caterpillar can support but a single one. I received this parasite from Miss C. Guild of Walpole, Mass., and Mr. E. Norton of Farmington, Conn., and have raised it from a chrysalis of *huntera* sent me by Mr. D. W. Beadle of Ontario. It has also been raised by Messrs. Bowles, Packard and Cresson. This shows how common it is. That sent by Mr. Beadle emerged September 25. The parasite makes its escape from the chrysalis case of the butterfly by biting off the head and a part of the thorax just above the upper shoulder tubercle, leaving only a slight fragment at one side to keep the lid thus formed in place. Even in a chrysalis which lay upon its side during the escape of the ichneumon, it could not wholly discard its ordinary operations, although forced at last to gnaw out a hole at one side, which it did at the base of the tongue and below. Mr. Riley also found among the

leaves of a deserted nest a large cocoon of *Microgaster*, but he has never bred the perfect insect. And finally, at Nepigon in 1888, I obtained *Apanteles cardicola* from the caterpillar in several instances, destroying the larvae in the second stage.

Desiderata. On what part of the leaf and during what weeks are the eggs of either brood deposited? Does the larva ever feed upon thistles or the other plants indirectly attributed to its bill of fare? Do any or a considerable number of the chrysalids of the first brood of the year remain until the close of the season before changing to butterflies, or how is the much greater abundance of the autumn butterflies to be accounted for? What become of the large ichneumons that emerge from the chrysalids in September? Do they then attack the larva of some other insect? Is the caterpillar ever attacked by parasites during the closing days of its life when it lives exposed and not in concealment? if so, why does it not continue in concealment? if not, what gives it immunity? How large a proportion of the chrysalids of the autumn brood disclose the imago during the same season? How many broods make their appearance near the dividing line between the Alleghanian and Carolinian faunas? In what respect does the flight of the butterfly differ from that of *cardui*?

LIST OF ILLUSTRATIONS.—*VANESSA HUNTERA*.

<i>Caterpillar.</i>	<i>Imago.</i>
Pl. 74, fig. 34. Mature caterpillar.	Pl. 2, fig. 2. Male, upper surface.
78: 52, 53, 60. Front views of head in stages i, ii and v.	3. Female, both surfaces.
81: 11. Nest.	12: 9. Both surfaces.
83: 64. Nest with chrysalis hanging within.	33: 22. Male abdominal appendages.
	38: 12. Neuration.
<i>Chrysalis.</i>	53: 5. Side view of head and appendages enlarged, with details of leg structure.
Pl. 83, fig. 54. Side view.	
63. Dorsal view in outline.	<i>General.</i>
64. Side view, hanging within a nest.	Pl. 20, fig. 8. Distribution in North America.
	83: 1. Ichneumon rufiventris, a parasite.

VANESSA CARDUI.—The painted lady.

[Painted lady; cosmopolitan butterfly; thistle butterfly (Auct.): *Cynthia* of the thistle (Kirby); thistle *cynthia* (Emmons).]

- Papilio cardui* Linn., Syst. nat., 10th ed., 475-476 (1758).
Nymphalis cardui Latr., Hist. nat. crust. ins., xiv: 87-88 (1805).
Cynthia cardui Fabr., Ill. mag. ins., vi: 251 (1807);—Harr., Entom. corresp., 277-279, pl. 1, figs. 1-2 (1869);—Kirb., Faun. bor. amer., iv: 295-296 (1837);—Emm., Agric. N. York., v: 210, pl. 46, figs. 1, 2, a, b (1834).
Vanessa cardui Ochs., Schmett. eur., iv: 16, 127 (1816);—God., Encycl. méth., ix: 296, 323-324, pl. 28, figs. 6, 6 bis; pl. 54, figs. 1, 1bis, 2, 3 (1819);—Boisd.-LeC., Lép. Amér. sept., 178-179 (1833);—Poey. Mem. Soc. econ. Hab., iii: 122 (1847);—Scudd., Amer. nat., x: 392-396, 602-611 (1876); Butt., 151, figs. 41, 134, 179 (1881).
Aglais cardui Dalm., Kongl. vetensk. acad. handl., xxxvii, 65-66 (1816).
Libythis cardui Lam., Anim. sans vert., iv: 29 (1817).
Hamadryas decora cardui Hübn., Verz. eur. schmett., 3 (1822).
Pyrameis cardui Doubl.-Hewits., Gen. diurn. Lep., i: 205 (1849);—Morr., Syn. Lep. N. Amer., 59-60 (1862);—Trim., Rhop. Afr. Austr., 119-121 (1862);—Saund., Can. ent., i: 93-94 (1869);—French, Rep. ins. Ill., vii: 154

(1878); Butt. east. U. S., 199-200 (1886);—Gundl. Ent. cub., 40-41 (1881);—Middl. Rep. ins. Ill., x: 87 (1881);—Coq. ibid., 153 (1881);—Fern. Butt. Me., 61 (1884);—Mayn., Butt. N. E., 19-20, pl. 3, fig. 22, 22a (1886).

Papilio carduelis Cram., Pap. exot., i: 40-41, 155, pl. 26, figs. E. F. (1779).

Figured by Glover, Ill. N. A. Lep., pl. 21, fig. 3; pl. 33, fig. 3, ined.

'Twas prime of May; and every square became
A murmuring camp of summer. Now and then
A dizzy and bewildered butterfly
Fluttered through noisy streets.

ALEXANDER SMITH.—*A Boy's Poem.*

Ah! if thou issueless shalt hap to die,
The world will wail thee.

SHAKESPEARE.—*Sonnet.*

Imago (2: 1; 12: 7). Head covered with reddish brown hairs mingled with a few blackish and many delicate white or gray hairs, the latter nearly wanting along the middle and about the base of the antennae, and abundant beside the inner edge of the eye; hinder edge of the eye broadly bordered with white scales, the field narrowing above where a few ochraceous scales are mingled with them. Palpi white, the upper surface reddish brown, on the apical joint brownish fuscous, with a few mingled paler scales; long hairs of the sides black. Under surface of antennae brownish luteous, the remainder purplish black, with a few scattered, pale scales above and a narrow, continuous line of white scales on the sides next the luteous portion; club pale orange luteous, all excepting the apical five joints, above, and sometimes to a less extent below, blackish, purplish above, reddish below. Tongue dark brownish luteous, becoming darker away from the base, black laterally, the apical half wholly black; papillae (61: 35, 54) nearly equal and cylindrical, slightly narrowing at the base.

Prothorax covered above with minute, dark metallic green scales, concealed by long olivaceous, and reddish brown hairs. Patagia reddish brown, tinged interiorly with olivaceous. Thorax covered beneath with long, white hairs, often tinged slightly with yellowish or brownish yellow. Fore tibiae black, covered in front with reddish brown, on the sides with white hairs, the outer ones somewhat tinged with reddish brown; femora of the other legs white, the upper surface blackish brown with intermingled reddish brown scales; tibiae and tarsi dirty white, the latter sometimes marked above with dusky, beneath with dark yellowish brown scales; spurs luteous, tipped with brownish red; spines black; claws reddish brown, darkest at tip.

Outer border of *fore wings* very gently sinuous, in no part straight, although nearly so both above and below. Third superior subcostal nervule arising at two-thirds the distance from the origin of the second to that of the fourth; the fourth at an equal distance from the outer border and the upper limit of the vein closing the cell. Above very dark, brownish black, the nervures black, the basal third of the costal margin, the basal two-fifths of the cell, a corresponding portion of the medio-submedian interspace, and the whole inner margin, heavily flecked with greenish golden scales; the remainder of the cell, excepting a narrow black edging along the exterior boundary, golden orange, deepest interiorly, palest exteriorly, crossed by two short, heavy bars; one with a rounded summit, scarcely narrower at tip than at base, depends from the costal nervule at about the middle of the cell and crosses nearly two-thirds of the cell; the other, rudely triangular, its interior edge scarcely separated from the exterior edge of the first, is seated on the median nervule, its apex near the middle of the cell or sometimes a little higher. The median and medio-submedian interspaces are almost wholly of the same bright tint; the outer margin of the wing, however, is margined here with black to the width of an interspace and the base of the lower median interspace, fully as far as the last divarication of the median, is filled with black and connects below with a pretty large, rounded or subtriangular spot seated on the lower median nervule, half way between its base and the black margin of the wing, and extending half way or sometimes wholly across the interspace; this again is in direct connection with a broad, curved band, which crosses the medio-submedian interspace

half way between the first divarication of the median nervure and the outer border,—the whole forming, with the outer bar in the cell, a greatly curved band, with an exceedingly tortuous, exterior margin nearly dividing the brighter parts of the wing into halves; the orange of the upper median interspace is infringed upon by a downward extension of the black field, in a rounded protuberance, with a very ill-defined edge, which barely crosses the middle median nervure, and limits the bright color to a little less than the basal half of the interspace and a small spot in the middle of the outer half, next the middle median nervure; there is also an orange triangle seated upon the upper median nervure near the extremity of its curved portion, leaving, along the outer limits of the cell, a black triangle projecting into the orange field, of equal proportions to itself. Crossing the upper portion of the wing, a little within the middle of the outer two-thirds, is a broad, nearly equal, white band, extending from the costal border to the lowest subcostal nervure, and a little broader than the width of the interspace at that point. A very little more than midway between this and the outer border is a strongly arcuate series of five white spots, the upper two occupying the upper interspaces and confluent, together forming a broad lunule, the third and fourth, in the next two interspaces, round, less than half the width of the interspaces, the fifth large, irregular, rounded, crossing nearly or quite the whole of the subcosto-median interspace. Distant from the outer margin of the wing by less than half an interspace, but retreating a very little more from it above, is a slender, transverse, faint, pale line; seated on the border, in the middle of the interspaces, are small, faint spots of dull, pale orange; fringe black, interrupted with white, below by short lunules, above abruptly. Outer border of *hind wings* very broadly curved, scarcely more so in the middle half. Color golden orange, the whole costal margin heavily bordered with blackish brown, the inner margin pale greenish griseous, the base, almost to the tip of the cell, blackish fuscous, sprinkled with greenish golden scales; the basal half of the medio-submedian interspace is also blackish brown, and from its lower extremity a rather broad, curving, mesial band narrowed and sometimes nearly obsolete in crossing the lower subcostal interspace, passes to the middle of the upper subcostal nervure; midway between this mesial band and the outer border, or, perhaps, nearer the former, is a transverse row of five pretty large, round, black spots in the subcostal, subcosto-median, and median interspaces, that in the upper subcostal usually merged in the broad, blackish border of the costal region; they are nearly equal in size, that in the lower subcostal interspace being largest; the lowest spot, and very seldom the others, have sometimes a few bluish scales in the centre, and that in the upper median interspace approaches the border more closely than the others. Distant from the outer border by less than the width of an interspace, is a series of transverse, diamond shaped stripes, each nearly or quite crossing an interspace; that in the medio-submedian interspace is a long, transverse, nearly equal dash, enclosing exteriorly a slender streak of pale blue scales; midway between this and the margin is another series of similar, but shorter and broader, diamond shaped, transverse spots, seated on the nervures and touching the outer border; fringe white, interrupted at the black spots, on the nervure tips, with black.

Beneath, the portion of the *fore wings* which on the upper surface is occupied by orange is pale, dull pink with a yellowish tinge on the outer half of the wing; but in the outer portion of the cell it is displaced by white; the black markings which belong to this field are, however, more limited in extent; the basal third of the costal margin is white, sometimes tinged with yellowish, crossed between the nervures by frequent narrow black bars; the base of the wing below the median nervure is lustrous greenish brown, the inner margin beyond it brownish fuscous, with an olivaceous tinge, and the extreme base of the cell a mixture of white, greenish and yellowish scales with a small, blackish spot in the middle, followed by a transverse whitish bar and this by another small black spot in the pink field—all in the basal third of the cell. The black band between the cell and the transverse white band depending from the costal border is filled in the middle, especially above, with a grayish mixture of pale brown and white scales, forming a sort of reversed triangle, the apex of

which meets that of the pinkish triangle seated on the median nervure; it also sends a tortuous thread to the lower sub-costal nervure, parallel to and in the neighborhood of the exterior border of the band. Beyond the transverse white band, which is edged rather narrowly with blackish, the apex of the wing is pale, dingy ochraceous; the white spots of the upper surface reappear, the two uppermost usually edged both exteriorly and interiorly with blackish, and, with another cloudy white spot in the interspace below, form a short band; the third and fourth spots are margined with black, more heavily interiorly than elsewhere, and on the same side are followed by a slender demiannulus of ochraceous, followed again by black; the fifth spot usually has a slight black line at its exterior margin; distant from the outer margin by about half the width of an interspace, and parallel to it, is a cloudy, white, continuous stripe, broadest above the penultimate subcostal nervule, bordered with dull blackish fuscous, especially on the narrower portion, which is much broader on the interior than on the exterior side; margin dull ochraceous, sometimes infuscated at the nervures; fringe white, interrupted moderately with black at the nervure tips. *Hind wings* dull brownish ochraceous, rudely marbled with various markings, the veins yellowish white, sometimes tinged with brown on the outer half of the wing; extreme base of costal border pale; a slightly tortuous, transverse, pale stripe, narrow, excepting above, crosses from the costal border to the median nervure, a little removed from the basal portions of the costal and subcostal nervures; it is margined interiorly with black specks and followed upon the costal border by a larger and a smaller black spot; near the middle of the cell a large, oblong, oval, transverse, black spot, largely bespecked with pale and ochraceous scales and narrowly margined with white, crosses the cell just below the first divarication of the subcostal nervure, its larger end uppermost; above it in the upper part of the costo-subcostal interspace is a fuscous spot, sprinkled with ochraceous; crossing the wing is an inconspicuous, interrupted white line, corresponding to the interior margin of the mesial band of *V. huntera* and taking the same direction as there; it is usually bordered exteriorly by a few blackish scales; crossing the base of the subcostal interspaces and the subcosto-median interspace just beyond, and including the tip of the cell, is a large, transverse, triangular, black spot, filled, excepting near its limits, with a considerable sprinkling of ochraceous scales, its exterior margin at right angles to the nervure; beyond this, the subcosto-median interspace is filled with a quadrate white spot merging exteriorly, at its narrowest part, into brownish; two subparallel, subcontinuous series of irregular, whitish, curved lines, at about three-quarters of an interspace's distance from each other, cross the wing beyond the middle; the outermost series follows a general shallow curve from about the middle of the outer half of the costal border to a little above the middle of the upper median nervule, and then another from this point to the middle of the medio-submedian interspace, where it turns inward again toward the inner border; each of these series is faintly edged interiorly with black, and in the medio-submedian interspace there is a fragment of a third series, parallel to the second; it is followed, like the portion of the second contained in the lower median interspace, by a considerable patch of white or yellowish white. There is a submarginal series of five circular or nearly circular ocelli in the subcostal, subcosto-median and median interspaces, distant about the width of an interspace and a half from the outer border; the uppermost is simplest and smallest, being a small brownish or ochraceous spot, with a few scattered black and blue scales near the centre, enclosed at the outer end of a much larger oval white field; the second has a large central disc of purplish black, with a few blue and ochraceous scales near the centre, and surrounded by a narrow annulus of dull yellow, bounded again, especially interiorly and exteriorly with black, the whole barely occupying the width of the interspace; the third and fourth are similar to each other, smaller than the second, and consist of a central disc of dull, dark green, largely besprinkled with bluish scales, which seem to avoid the blackish edge, the centre and to some extent the exterior portions; it is surrounded by a narrow, dull yellowish annulus, which becomes white interiorly, and usually expands somewhat in the same region; in the fourth, this is usually bounded below by black; the fifth is of the size

of the second and similar to it, but has a dull, dark green ground with numerous bluish scales, especially upon the interior half and is edged below with black; the whole of this is surrounded by a narrow yellow annulus, which is ochraceous next the bluish scales and this encircled narrowly with black; the outer border for the width of less than half an interspace is pale ochraceous, the very edge a little darker; it is bordered interiorly by a rather coarse blackish line which becomes slightly slender in the interspaces; this is followed by a whitish band, nearly twice as broad as the marginal band, tapering toward the costal edge and enclosing next its interior border an interrupted series of transverse, fusiform, pale blue bars, narrowly edged with black, that in the medio-submedian interspace almost entirely black. Fringe white, interrupted rather narrowly at the nervure tips with blackish, which occasionally encroaches slightly on the wing itself.

Abdomen above purplish black, heavily flecked, especially on the sides and on the apical half of the segments, with yellowish fulvous scales; beneath white. Appendages of male (33:31): upper organ not large, the body less compressed than in the previous species, slightly arched longitudinally, the hook straight, bent a little downward, rather small, shorter than the body, depressed, very broad at base, narrowing to near the tip, and this portion equiangular, the apical fourth equal, as broad as high, bluntly pointed. Inferior arms straight on a superior, arcuate on a lateral view, slender, tapering irregularly to a simple point. Clasps about half as long again as broad, the inferior edge more strongly curved than in the other species, considerably reflexed, especially on the basal half; posterior border produced a little below the middle to an angle much larger than a right angle, not incurved; the upper posterior angle considerably produced to much less than a right angle, finely pointed and somewhat incurved; lower posterior angle lost in the curve of the under edge. Interior ribbon rather stout, compressed, tapering on the apical half, the basal half concealed in the reflection of the inferior border of the clasp, much shorter than in the other species, not nearly reaching the angle of the posterior edge of the clasp, toward which the tapering, sinuous, apical half is directed. There is, besides, near the centre of the inside of the clasp, a small, depressed, horizontal tooth, shaped like a shark's tooth, directed inward.

Measurements in millimetres. Length of tongue, 9 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	29.5	32.	33.5	31.5	36.5	38.5
antennae.....	16.		16.75	15.5	16.25	
hind tibiae and tarsi..	11.5	10.75		10.25	11.75	
fore tibiae and tarsi..	5.	5.5	5.5	5.	5.	

Aberrations. A variety described by Ragonot (Entom. month. mag., v: 229-230) from a specimen obtained on Sand Hill at Wallasey, England, has a bleached appearance as if for protective resemblance to the sands. As described by Ragonot, the upper surface is much paler than in ordinary specimens, the disk of the fore wings being quite free from the dark markings, excepting a small blotch in the cell and another in the medio-submedian interspace. On the hind wings the usual dark markings are also absent, excepting on the margin which in the front wings is normal. On the under side the ground color of the hind wings and the base of the fore wings are ashy white, while the normal darker markings are obscure or absent, excepting next the outer border of the wing.

V. C. ELYMI (*Van. elymi* Ramb., Ann. soc. obs., ii, pl. 5, figs. 1-2,—1829; *Van. cardui*, var. Herr.-Schaeff., Schmett. Eur., i, Suppl., figs. 157, 158,—1843; *Van. cardui*, aberr. *inornata* Brams., Ann. soc. ent. France, (6) vi: 284,—1886). Strecker (Syn. Macrolep. N. A., 137) thus describes this suffused variety from two New Jersey specimens in the collection of Mrs. Bridgham of New York.

“Normal form of ornamentation obliterated. Upper side of primaries has the basal half covered with an orange yellow blotch; subapical white spots confluent. Second-

aries orange yellow; on costal parts blackish, this color extending along the veins to the outer margin; before it reaches the latter this color broadens into diamond-shaped marks; a submarginal row of white spots. Under side of primaries much as above, but with a broad, white, submarginal band. Secondaries mottled pale grayish, with a broad, white, marginal band; in some instances nearly the whole surface of secondaries beneath is white, in others the white predominates on the upper surface to the greater exclusion of the black."

Another specimen taken in Belgium has been described and figured by Donckier de Donceel (Ann. soc. ent. Belg., xxi: 10, pl. 1, fig. 1, 1878). In this the white bar depending from the costa of the fore wing is absent but the sub-apical white spots are not confluent but somewhat enlarged, especially that in the interspace beyond the cell. A supplementary white lunule is found in the upper median interspace. The upper surface of the hind wings differs from that described by Strecker in that the sub-marginal row of white spots is absent, though the diamond shaped marks are very distinct. The under surface of the hind wings also differs in that the margin, like the fore wings, is marked by a narrow fulvous band preceded by a narrow fuscous stripe and this by an ashen band in which the ocelli are situated, which number only four.

In the collection of the late Dr. Harris, now in the Museum of the Boston society of natural history is a female (No. 35c) which has the fore wings and only the fore wings suffused, and although only to a slight degree it is apparently in the same direction as the preceding specimens of this aberration. On the upper surface, the outer limits of the orange area are much the same as usual, excepting that in the lower median and medio-submedian interspaces, the black bordering of the wing encroaches upon it by extending inward in the middle of each interspace nearly twice as far as usual; within the orange area, as far as the fuscous base specked with greenish, the black markings are almost entirely wanting; all that remain are: first, the large, black spot, depending from the subcostal nervure in the middle of the cell, which is larger than usual and reaches nearly across the cell; second, a narrow fuscous bar extending upward from the submedian nervure a little more than half way across the interspace, in the normal position of the commencement of the tortuous band, but much narrower than usual; and, third, a few blackish scales flecking the upper and part of the lower edge of the lower median nervure. On the apex of the wing, the transverse white bar depending from the costal margin is entirely wanting and the white spots in the arcuate row beyond it are larger than usual, their limits vague instead of precise and showing, especially the upper ones, a tendency to merge into the white spots, also enlarged, of the submarginal series. Besides, faint indications of a sixth small spot in the upper median interspace are visible just below the largest spot of the arcuate row. Beneath, similar differences are noticeable, excepting in the rows of white spots and in that the outer margin is of the ordinary width in the lower half of the wing.

The specimen from Ekaterinoslaw in southern Russia described by Bramson under the name of *inornata* seems to approach very closely to this, but the aberration is a little more marked in some particulars though less so in others. In particular the ocelli of the under surface of the hind wings in the Russian specimens are said to be situated on a pale rose ground: while on the other hand a trace of the white bar depending from the costa of the fore-wings is seen in a narrow marginal line.

V. C. ATE (*Pyrameis cardui. ab. b. ate* Strecker, Syn. Cat. macrolep. N.A., 187,—1878). "Upper surface primaries suffused heavily with blackish, the normal markings entirely gone, the orange confined to a blotch or disc, on half of wing towards the inner margin, said blotch merging into the blackish on all sides; the large, subapical, white bar* entirely wanting. Secondaries obscured with blackish, the row of black spots faintly discernible and pupilled with white points. Under side primaries much as on upper side, secondaries black except along the abdominal margin where the ordinary coloration and marking is retained; veins white; the six ocelli as in ordinary form;

* That is, presumably, the bar depending from the costa in the middle of the outer half of the wing, and not the premarginal row of spots.

a narrow yellowish or clay colored margin exteriorly. Body white beneath. Taken in Summit Co., Ohio." (Strecker.)

Plainly belonging to this same variety, though it has not yet been recognized in Europe, is the form described and figured by Dr. Hofmann (Jaresh. Ver. f. vaterl. naturk. Wurt., xl:328, pl. 6, fig. 3, 1885), raised in Tübingen from the caterpillar. Although the figure is not colored and the description is meagre, it is plainly very similar indeed to the preceding, though it possesses on the upper side of the fore wings an orange blush at the end of the discal cell not mentioned by Strecker, and the sub-marginal spots at the apex are much enlarged and nearly confluent. A band, not mentioned by Strecker, on the hind wings, and a row of black spots faintly discernible in the Strecker specimen and pupilled with white points, here show in the photogravure as tolerably large, white spots. The under surface of the hind wing, not shown in the figure, is described as being yellow-gray with darker markings than ordinary.

To this variety should also be referred the butterfly figured by Donckier de Donceel (Ann. soc. ent. Belg., xxi: 10, pl. 1, figs. 2, 3, 1878), taken in Belgium. In this the darker markings are not so pronounced, the whole wing being merely infuscated. As in the preceding, the white bar depending from the costa of the fore wings is absent, and the sub-marginal spots of the apex are larger than usual, and are here represented as accompanied by supplementary spots nearer the border. The hind wings have the two sides different; the sub-marginal spots of one side being fuscous in yellow lunules, and on the other white at the outer termination of elongated oval yellow spots. The under surface repeats to a large extent the markings of the upper especially upon the front wings. But the normal colors of the ground are separated in a curious way so that in the basal half the brown predominates and in the apical half the olivaceous.

Mr. A. Phipson exhibited to the Entomological society of London in July, 1880, a remarkable variety of this species taken in southern England the year previous, in which the oblique white band descending from the costa of the fore wings was of double the usual width, while the premarginal white spots were reduced to mere dots, and the fulvous color in the median area was entirely confined to a premarginal band about as wide as the white band above. The hind wings showed nothing extraordinary, and the under surface was not shown. It is figured on p. 20 of the Proceedings for 1880, and does not appear to vary in the direction of any of the other aberrations, in that the comparative values of the white costal bar and the premarginal row of white spots of the fore wings are exactly reversed from what is found in all the others.

Egg (64:30). The ribs vary from fourteen to nineteen, but in the majority of cases are sixteen in number; they are very thin and hardly increase in height until the summit is reached. The surface of the egg is not quite smooth, but is not punctate, and the faint and delicate cross lines which cross the ribs as well as the general surface are about .025 mm. apart. Micropyle (67:7) consisting of a cluster of a dozen or two roundish polygonal, subequal cells, those at the centre not much smaller than the rest. Color of egg uniform pale green. Height, .75 mm.; breadth, .58 mm.

Caterpillar. *First stage.* Head dusky brown, mouth parts paler, eye specks blackish. Body pale, dirty green; hairs (86:69) dusky, long and curving, seated on a tiny wart not so high as broad.

Second stage. Head shining black; all the appendages black. Body dark umber brown, mottled with paler brown, forming obscure mediodorsal and stigmatal bands; a roundish greenish yellow spot around the base of the laterodorsal spines of the second, fourth and sixth abdominal segments; appendages consisting of sugar-loaf shaped papillae (86:70) nearly twice as high as broad, terminated by a slightly curving bristle about two and a half times longer than the wart; furnished also on the middle of the sides with a whorl of about four aculiform spines, directed upward at right angles to each other; legs and prolegs black exteriorly; spiracles black in a pale annulus.

Third stage. Head (78:61) as before; body darker, approaching black, the markings as in the previous stage, but in addition there are yellow spots at the base of the dorsal spines of the before-mentioned segments and often at the base of other spines,

and especially on the upper part of the body where pale markings have predominated. Appendages consisting of conical warty processes (86:71) several times higher than broad, seated on low inconspicuous mammulae and terminated each by a straight aculiform spine nearly as large at base as the docked tip of the process, and of about the same length; the latter furnished just above the middle by a whorl of four (or more) aculiform spines directed upward at right angles to each other, and seated on little warty processes or projections, together about half as long as the main process; midway between these and the base is sometimes a similar whorl of spinules, more nearly horizontal and seated on similar warts.

Fourth stage. Coloration much the same as in the succeeding stage. As to the appendages (86:72), the process has become a stout tapering spine, many times higher than broad, tipped by a straight needle half as long as itself and furnished near the middle with a more or less irregular coronet of tapering spinules, fully as long as the width of the main spine at the point, diverging at about right angles with each other and surmounted by a needle nearly as long as the main apical one; midway between this coronet and the base is a secondary one similar to that found in the third stage.

Last stage (74:37). Head (78:63) blackish brown, very delicately scabrous, covered with large and rather infrequent tubercles and numerous warts, being very long, white, tapering hairs, the warts on which they are seated usually white, but occasionally dull luteous, the latter occurring in a short streak which passes down the front from the summit of either hemisphere, and also in a narrow streak curving around the ocellar field and passing also upward; a few black hairs are formed on the summit. First joint of antennae dull luteous; second fuscous at base, beyond dull luteous; third brownish yellow, the bristle pale; ocelli very dark reddish brown; labrum blackish, edged with pale below; mandibles blackish; maxillary palpi brownish yellow, the extremities of joints annulate with fuscous.

The prevailing hue of the body is a pale, dingy, olivaceous yellow, brightening in places so as to form broken longitudinal stripes, of which there is a nearly continuous double dorsal one, divided by black, an almost entirely continuous one on the infra-stigmatal fold, and on the anterior half of the segments, and a longitudinal dash in front of the laterodorsal and laterostigmatal spines; otherwise the body is very heavily and irregularly mottled with velvety black, most distinct on the sides of the thoracic and first two abdominal segments between the two rows of spines above the spiracles; and on the succeeding segments, to a less degree, in the same region, but only on the anterior half of the segments and just above the yellowish patch already mentioned; the anterior half of the first thoracic segment and the posterior half of the last abdominal segment are fuscous above; the body is profusely covered with minute pale yellowish wartlets, from each of which arises a long, curved, tapering, pellucid hair, they being more conspicuous than in the other species; spines (86:73) pellucid or pale yellowish, the longest ones scarcely exceeding in length one half the extreme width of the head, the apical spinule, or that portion of the main stem which lies beyond the base of the lateral spinules, much larger than the other part of the spine, the spines being but little elevated at their base; the spiniform tubercles of the first thoracic segment are very short. The spine has become more or less irregularly conical, owing to the influence of the spinules upon the main stem; the apical needle is scarcely one-fourth the length of the spine, the spinules in the upper coronet are more than twice as long as the width of the spine at their base and the needles tipping them are of about the same length as the central one; the subordinate series of spinules have assumed the importance of the primary series of the previous stage, are nearly as long as the width of the spine at their base and are surmounted by needles nearly double the length of those in the upper row. There are also at various points on the spine, and particularly next its base, minute warts giving rise to delicate short needles; spiracles velvety black, bordered with pale yellow; legs dark brownish yellow, their base and the lower part of the segment between the base, fuscous, the second joint blackish, especially toward either extremity, the claws black; prolegs brownish yellow. Length of body, 30 mm.; breadth of body, 4 mm.; length of spines, 2 mm.; breadth of head, 3 mm.

In the above description I have given the characters of single individuals in order to give the details without confusion; for this species varies to nearly the same extent and in much the same direction as its ally *V. atalanta*. The dots upon the surface often assume a yellowish or saffron tint, extend, and sometimes become confluent, so as to produce snuff colored individuals, very similar to the same form of *atalanta*; but they are not nearly so common as there; sometimes also, as in that species, they are entirely black, and the spines are very frequently black, although their bases may be of a lighter tint. This description was drawn up in Europe from European specimens.

In an early, probably the third stage, the spines are conical, about twice as high as broad, with only two to four sessile needles, which are straight and not very long and surmounted by a curved hair, fully twice the length of the spine. Very commonly in the third and fourth stages, the dorsal and laterodorsal spines of the second, fourth and sixth abdominal segments are seated upon yellowish spots, those of the same row often obscurely connected by longitudinal stripes, connecting their edges, of a greatly infuscated yellow, frequently also, when the other spines are blackish or infuscated, those specified above are yellowish or orange in tint. In one caterpillar, which I found at Nepigon on *Anaphalis*, the spines were white, seated on coral red papillae and with black thorns.

The variations of American examples will be found described by Harris (Entom. corresp., 277-279) and by Saunders (Can. ent., i: 93-94).

It may be distinguished from *atalanta* by the length of the hairs upon the head and body, and the relative length of the apical portion of the spines to the basal portion.

Chrysalis (83: 60-62). Golden or greenish nacreous, or pale bluish white, the wings more or less streaked with broad irregular bands of pale dirty brown, black in the wrinkles, all directed parallel to the nervures; basal wing tubercle marked with black and golden running down its sides; three or four black dots in the interspaces parallel to but distant from the upper posterior border. Ocellar prominences but little protuberant; mesonotal median prominence not quite so high as in the other species. Tongue pale brownish fuscous, deepening to blackish at the tip; the inside of the eyes the same, narrowly edged outwardly with black; antennae and inner edges of the legs of the same color but a little paler, the former with a small squarish black spot on either side of the tip of each segment; legs with a roundish black spot on the outer side of the tip of the tibiae, beside and above which the leg is golden, even in the palest specimens. Almost the whole back is tinged with very pale dirty brown (sometimes with a greenish tinge and occasionally on the fifth and succeeding abdominal segments changing to livid brown) excepting a pretty large oval spot behind the mesonotal median tubercle, a slender dorsal line on the abdomen and the laterodorsal tubercles, which are of the brighter color; in the paler specimens all the tubercles are tipped with gold. There is also a slender stigmatal band of pale dirty brown, besides broader, very indistinct ventral and lateroventral bands of the same color; black dots are sparsely scattered over nearly the whole dorsal surface, but are seldom present on the paler or brighter parts; they are also found on the ventral surface of the abdomen, but generally minuter, excepting a few larger ones arranged at the outer edges of the ventral band, along the middle of the lateroventral band and just below the stigmatal band, one in each segment near its middle; suprastigmatal and infrastigmatal rows of warts obsolete; basal and supernumerary wing tubercles not so pointed as in the other species; laterodorsal tubercle of the eighth abdominal segment nearly or quite obsolete; spiracles concolorous with the body, with dull luteous lips; cremaster pale, laterally edged with a heavy black line, the median groove above also black; apical field of anal hooklets nearly twice as long as broad. Length, 20.5-23 mm.; of cremaster, 1.5-1.6 mm.; greatest width, 7.25-7.5 mm.; at ocellar prominences, 3.6-3.85 mm.; height at mesonotal prominence, 7.-7.15 mm.; at base of abdomen, 5.5-6 mm.; at third abdominal segment, 6.5-6.9 mm.

Distribution (21: 1). The range of this butterfly is so extended as to merit the term cosmopolitan. With the exception of the arctic regions

and South America, it is distributed over the entire extent of every continent. Australia and New Zealand produce a race peculiar to themselves, while the other large islands south of Asia possess the normal type, which is also found upon small islands lying off the western borders of the Old World, the Azores, Canaries, Madeira, and St. Helena. On the other hand, it has not been discovered upon the small islands off the American coast, such as Guadalupe, the Revillagigidos, and Galapagos on the western side, or the Bahamas on the eastern,—excepting in Bermuda, where it is “common” (Jones); neither does it occur in any of the Antilles, excepting Cuba, and there but rarely.* It is reported, however, from islands lying in the middle of the Pacific Ocean, such as the Hawaiian group and Tahiti, but its normal occurrence there is at least doubtful unless it has been recently introduced. And here I may remark that the improbability of the occurrence of this insect upon islands lying in the middle of the Pacific Ocean has led me to look carefully into the origin of this general belief. The sole authority for Tahiti is Boisduval, who remarked forty years ago (*Nouv. ann. mus. nat. hist.*, ii: 191) that he possessed specimens from Tahiti, Brazil, Cayenne, etc.; but it should be noticed that *V. cardui* is not now recognized from Brazil and Cayenne, and that Dr. Boisduval is not considered too careful in his geographical statements; moreover, Mr. A. G. Butler does not mention it in his *List of the diurnal Lepidoptera of the South Sea Islands* (*Proc. zool. soc. Lond.*, 1874, 274 seq.), and Dr. C. Pickering, the naturalist of Wilkes’ Exploring expedition, told me that it was unknown on Tahiti in 1839.

A citation of the Hawaiian Islands will be found in the first *List of the British Museum butterflies*, where (p. 79) Mr. Doubleday credits four specimens to those islands, two brought by Captain Bryon and two by Captain Beechey. I was informed by Mr. Butler some years ago that there was then only one specimen in the museum from the “Sandwich Islands,” and the reference upon the ticket is to the oldest manuscript register, not now to be found. Bryon and Beechey were at the islands in 1825-27. Mr. W. T. Brigham informs me that *V. cardui* was not found by Mr. Mann and himself during a twelvemonth’s residence at the islands twenty or more years ago. Dr. Pickering writes that it was unknown when Wilkes’s expedition visited the islands in 1840-41. The Vincennes, to which Dr. Pickering was attached, was at the islands from the end of September to the beginning of April. Bryon and Beechey’s visits were between the latter part of January and the middle of July. Mr. Butler does not consider the specimen in the British Museum, nor the record of Doubleday, sufficient authority to include this insect in his list of South Sea butterflies. Upon the whole, we cannot fairly accept the present

* Cramer gives it, but probably by mistake, latest list of the Lepidoptera of Jamaica, by from Jamaica. It is not mentioned in the Möschler.

authority for the presence of this insect in the Pacific Islands, unless, as said above, it has been recently introduced; for Mr. Blackburn, writing to the Entomologist's monthly magazine, says it appeared in considerable abundance in 1879 at various points in the Hawaiian archipelago, though not previously noticed in two years' residence there. Dr. H. Behr of California wrote me in 1877 that he had received it from Honolulu, where it was collected by Mr. Leykauff about the year 1859.

On the American continent, its southern boundaries will probably be found in Venezuela, New Grenada, and Ecuador,* but it is abundant even as far south as the highlands of Guatemala, and thence stretches northward over the entire breadth of the continent nearly to the arctic regions; on the eastern coast it has been found as far as the Atlantic shore of Labrador, and on the west to British Columbia. Wagner (Sitzungsb. k. b. akad. wiss., 1870, ii: 170) asserts that this butterfly is found on "all the Aleutian Islands," which is certainly incorrect. Captain W. H. Dall, whose natural history explorations in Alaska are well known, writes very positively that there are no macrolepidoptera whatever on any of the islands west of Unalashka; a fact he easily explains by the absence of trees or shrubs, the strong winds and the wide straits that separate the islands. East of Unalashka he knows of but two butterflies, a *Pieris* and a *Polygonia*. Neither was it found by Dall in Alaska proper and probably it does not occur there, though Wagner, probably with equal inexactitude, states that it is a common summer insect on Bering Strait; he does not state on which side. In the heart of the continent I have taken it upon the Saskatchewan, Doubleday reports it from Martin's Falls, and Mr. Jenner Weir found it among the insects collected by Haydon at the southern extremity of Hudson Bay; but Mr. W. H. Edwards does not recollect seeing it in the collections he has examined from other points in the north; probably it does not extend in any abundance north of the annual isotherm of 35° F.

As we see it flourishing in the colder regions of Europe and North America, so also is it found on all mountain heights; and Mr. H. W. Bates, writing of the whole genus, distinctly says it is "found only in elevated places in the neighborhood of the equator." The stations in southern Asia from which *V. cardui* has been reported, — Cashmere, Nepaul, Bootan, and Sikkin, — all lie on the flanks of the Himalayas, and the Nilgherry Hills, where also it occurs, are the highest elevations of the Indian peninsula. A single example is recorded by Distant from Penang Hill, Straits Settlements, less than three thousand feet high; and it is also recorded from Madagascar, Bourbon, Mauritius, Formosa, Ceylon and the Sunda Islands in the Indian Ocean. According to de Nicéville it "occurs

*Wagner took a single specimen near Quito in an eight months' residence there. Mr. W.

Bartlett Calvert of Santiago informs me that it is also found in Peru.

almost everywhere" in India, though he adds that "it is decidedly rare in Calcutta." In the Alps of Europe this insect flies to the snow level; but in North America, although it may be regarded as one of the commonest butterflies in the elevated central district, it is most abundant at a level of seven or eight thousand feet. Lieutenant W. L. Carpenter and others have never found it above the timber line; but Dr. Packard has taken it on Arapahoe Peak, between eleven and twelve thousand feet, and on Pike's Peak from eight thousand feet to within five hundred or a thousand feet from the summit. Professor F. H. Snow has also taken it on Pike's Peak, and the late Mr. J. D. Putnam at the height of 12,500 feet east of Berthoud's Pass.

Boisduval states that it is much rarer in America than in Europe; but my experience has been quite the opposite and is confirmed by Doubleday's remark (Gen. diurn. Lep., i: 204): "I have never seen it so plentiful in Europe as I have in the United States, especially in Ohio, where I have seen literally tens of thousands on the thistles by the roadsides." In Egypt I found it far more abundant than in Europe.

There is no spot in New England where it may not be found at certain seasons in abundance. It is an occasional visitor to the barren summits of the White Mountains, but nowhere in New England is it so abundant as in Nantucket.

Irregularities of appearance. "In England and on the continent of Europe," says Trimen (Rhop. Afr. austr., 121) "*cardui* sometimes appears in great abundance, and then, perhaps for several seasons, will be uncertain in appearance and restricted to particular localities. I have not heard of this irregularity of appearance being noticed in other parts of the world." This is, however, the universal testimony of observers in America, and is probably due to the action of parasites. It was one of the first phenomena that drew my especial attention to butterflies. This butterfly, indeed, is one of the best subjects of study for those who wish to investigate the causes of irregular apparition; and only such as spend much time in the field can hope to solve the problem. A close observation of the comparative abundance of the butterfly for several consecutive years in the same locality, accompanied by an attempt to rear hundreds of the caterpillars (selecting only those which are nearly full grown, and recording the proportion of healthy and infested ones), will probably show whether the attack of parasites is a *vera causa*. In New England it was noted as very common in 1878, then very scarce until 1884 when it was extremely common, and equally so over a very wide territory, causing great alarm among the farmers in Manitoba (Can. ent., xvi: 177, 211) lest it should be injurious to some of their crops. In 1885 it was again scarce in New England, abundant again in 1886, and in 1887 rarely seen.

This irregularity of appearance is sometimes due to immigration from

other districts. That its power of flight is great we know from independent sources. Thus Trimen relates that a specimen flew on board a vessel in which he was sailing, when about ninety miles from Teneriffe; and another writer speaks of one visiting a vessel six hundred miles from the African coast during a cyclone; other similar though not so striking instances might be added. The immense swarms which covered Europe in 1879 are attributed to such immigrations, but these are spoken of more in detail in another part of this work, to which the reader is referred.

Oviposition. I have observed egg-laying at various hours from 10 A.M. to 4 P.M. The ovipositing female alights upon a plant and moves about with trembling wings, and body generally on a line with the midrib, until it finds a spot to its taste; the wings, elevated at an angle of about forty degrees with each other, now become quiet, the tip of the abdomen is bent down upon the leaf, and the egg is instantly laid. I observed one butterfly alight many consecutive times on unopened thistle heads, thrusting her abdomen between the spines to the very sepals, as if in the act of ovipositing; but no egg was laid until she alighted on a leaf. The same butterfly appears never to lay more than a single egg upon one leaf, although she frequently deposits eggs on different leaves of the same plant, and in one particular instance laid them upon cut leaves lying on the ground; in this case she laid them upon the uppermost surface, whichever way the leaf was turned; on the plant they are always laid upon the upper surface; and I once found an egg on a spinous hair of a thistle-leaf. Several eggs may sometimes be found on the same leaf, but they will always hatch at different times, showing that they were laid on different occasions, if not by different individuals. The eggs themselves vary considerably, their vertical ribs ranging from fourteen to nineteen, and averaging fifteen and a half or sixteen in number; judging from the examination of forty or fifty specimens, it would seem as if the average were slightly greater in America than in Europe. The duration of the egg-state is from six to eight days.

Food-plant. The caterpillar feeds principally on Compositae and especially upon the tribe of Cynaroideae, or thistles.

“Just what they want the thistle brings,

But thistles are such surly things.”

In our country it has been found on *Centaurea benedicta*, *Cnicus lanceolatus* (the common thistle), *C. arvensis*, *Carduus nutans*, *Silybum marianum*, *Onopordon acanthium*, and *Arctium lappa* (burdock),—all plants introduced from Europe; also on *Senecio cineraria*, belonging to another tribe of Compositae; on another of the Compositae, one of the sunflowers, *Helianthus* sp.; on still others, *Anaphalis margaritacea*, in company with *V. huntera*; and (by J. Fletcher) on cultivated *Artemisia*; on one of the Malvaceae, *Althea rosea* (garden hollyhock), and one of the borage family,

Borrago officinalis,—both again introduced plants; and it is reported (perhaps by mistake for its congener, *V. atalanta*) to have been found on the nettle. Möschler remarks that he has received neither thistles nor nettles from Labrador, and wonders upon what the caterpillar may feed in that inhospitable region; we would suggest that *Artemisia* or *Anaphalis* may serve it. In Europe it has been taken upon various species of *Carduus*, *Cnicus*,* *Onopordon* and other *Cynaroideae*, such as *Centaurea benedicta* and *Cynara scolymas*; one of the *Anthemideae*, *Achillea millefolium*, and some *Inuloideae*, such as *Gnaphalium arvense*, and *Filago arvensis*; on *Echium*, one of the *Borraginaceae*, and on *Malva rotundifolia*. It is also reported now and then on nettle, but perhaps erroneously, its resemblance to *V. atalanta* being deceptive. It should, however, be added that its occurrence on nettle has been especially noted in remarkable *cardui* years. Rambur says that after having devoured *Carduus*, *Cnicus* and *Centaurea*, it attacks *Echium*, *Ulmus*, etc. It seems to prefer the *Malva* in Egypt, being found abundantly on the species cultivated by the Arabs for medicinal purposes and called by them *Mlukkeh* (pronounced *Molochia*), while the thistles growing abundantly by the railways are untouched; since this mallow is cut at various times during the winter, myriads of the caterpillars are doubtless annually exterminated. Examining one September in the Botanic Garden in Cambridge a whole series of thistles growing side by side, I found that the butterfly had chosen almost exclusively a plant of *Onopordon*, a few larvae being found also on a couple of European species of *Cnicus*. In Java, according to Horsfield, it feeds on an *Artemisia*, called *Godomollo* by the natives; in Ceylon also on *Artemisia*, according to Moore, and in Bombay "on different species of *Blumea*" according to Aitken, quoted by de Nicéville.

Habits of the caterpillar. The young caterpillar makes its escape from the egg, as usual among lepidopterous larvae, by biting a slit almost around the crown of the egg, and pushing up this improvised lid; it does not appear to devour the egg-shell, as caterpillars usually do, but, after biting a few little holes partly through the upper surface of the leaf, makes its way to the opposite side and takes up a position, each one apart from its fellow, either between the midrib and curled-up rim, if near the tip of the thistle leaf, or next the midrib or a lateral rib, if farther back, or between the tips of the crenulations; here it bites away the silken film of the leaf and makes a nest, covering itself with a slight open web, into which it weaves the bitten particles of the film. From this retreat it sallies forth to eat irregular patches in the parenchyma, which it often partially covers with an extension of the web.

Each caterpillar, when it has outgrown this confined abode, builds for

*Speyer says that in a period of great abundance *cardui* feeds on *Cnicus arvensis* and *lanceolatus*, but leaves untouched *C. oleraceus*

and *palustris*, the first two of which are found in America, the last two not.

itself a separate nest (**81**:10) generally near the summit of a stalk, and now on the upper surface of the leaf; it spins a thin web on the surface, near the edge, if it be a broad-leaved plant, and then draws over a portion of the leaf by means of threads, completing the covering with a silken tent; when half-grown it forsakes this and forms a more perfect nest, drawing together leaves, buds, and bitten fragments by the same process, so as to form an irregular oval cavity, about thirty-five millimetres long vertically, and a little more than half as broad. The narrow, irregular, crisped and rather distant leaves of the thistle, on which it is most frequently found, cannot, however, be made to cover even a single caterpillar, and the spaces are closed by a thin open web, through which the inmate can readily be seen, but which is sufficiently close to retain all the rejectamenta of the caterpillar. The nest is usually covered, at least in the upper half, with spines of the plant, evidently bitten off for the purpose; there is an opening in the nest, near or at the summit, just large enough to allow the larva to emerge, apparently made by eating away the web. The leaves which penetrate the nest are not lined with silk, but the web is frequently stretched across the inequalities of the leaf. Within this habitation the larva rests with its head downward, like its congener, *V. atalanta*; but, unlike it, when its earlier stages are passed, it feeds upon the upper surface and parenchyma of the leaf, without touching the under cuticle, and when these are consumed, it crawls out to seek its fortune and weave a more commodious mansion; when, however, it has reached its fourth stage, it devours the entire leaf, and not the upper cuticle alone. If it is born upon one of the broader-leaved forms of thistle it constructs its home by first weaving a silken web across the narrower parts of the crinkled leaf, uniting the upper edges but drawing them together very slightly. In this passage it lives until nearly half grown, when it makes a web-nest difficult to describe from its irregularity; but it is a very thin silken enclosure of an oval flattened form, with an opening at any point, the web covering the outer surface of a leaf, with its projecting lobes curled over into the web; this is more or less foul with excrement and bitten off spines, while the included parts of the leaf have been despoiled of their parenchyma. When still older several leaves near together may become involved, but the leaves when eaten are bitten completely through.

When about to undergo its transformation, the caterpillar does not wander far, and frequently remains upon the plant which has nourished it. A specimen bred in confinement, but which had abundance of room, formed of partially dried leaves, connected by open, angular, irregular, silken meshes, averaging about four millimetres long, a sort of cocoon, of no definite shape, but larger than its previous nest, and which it attached to the top of the cage. In another instance one underwent its transformation within its nest (**81**:10).

Life history. Notwithstanding the ubiquity and general abundance of *Vanessa cardui*, its natural history is still imperfectly known. Of its life in the tropics there is no published statement beyond the mention by the indefatigable Horsfield, that in Java the butterfly appears in December. Just beyond the tropics, at the Cape of Good Hope, Trimen reports it as found in the imago state throughout the year, but most abundant from September to March. At about an equal distance north of the tropics, on the same continent, in Egypt, this butterfly flies through the winter, and I have found caterpillars in almost every stage from November to March.

In New England this butterfly is double-brooded and hibernates in the imago state,—at least so far as is known. In Europe, according to some writers, it often passes the winter in the chrysalis state; but authorities do not agree upon this point. The hibernating butterflies do not usually begin to emerge from their winter quarters until the middle of May, and badly worn specimens continue to fly until after the middle of June. They lay their eggs during the latter half of May and early in June; and the caterpillars therefrom become fully grown between the middle of June and the end of July; the chrysalids hang from eight to fourteen days, and disclose the first fresh butterflies about the 10th of July. These usually become abundant by the middle of the month, and at the end of the third week innumerable (though it would appear as if they sometimes were delayed until the first week in August); they continue to emerge from the chrysalis until the early days of August, and fly until the next brood appears; they lay their eggs during the last of July and the first of August, and the caterpillars undergo their final transformations in the latter half of August and early in September, the autumn brood of butterflies first appearing late in August and continuing on the wing until the end of October, when they hibernate. In the south they fly all winter.

This account does not correspond with the history of the same insect in Europe. Meyer-Dür states that in Switzerland the butterfly may be seen on the wing from April to the end of June (wintered specimens), and from the middle of August until late in October; that is, it is single-brooded. Many authors speak of it as double-brooded, without mentioning the specific times at which it may be found; while others give the same seasons as Meyer-Dür and call it double-brooded, mistaking the double apparition of the same brood (winter intervening) for distinct broods. My own observations in the neighborhood of Geneva and Paris lead also to the conclusion that the insect is single-brooded; and the only entomologist, to my knowledge, who has given two distinctly separated dates for the apparition of the caterpillar is Reutti, who says in his *Fauna of Baden*, to which my attention was called by Dr. Speyer, that caterpillars are found in June, August and September. But Dr. Speyer thinks

there is but one brood. From the time of Ochsenheimer, however, who repeatedly says, "Ich habe zwei generationen bemerkt," different authors have claimed for this insect a double brood; and until direct observation shall have determined the point, it should be considered, at least for some parts of Europe, an open question. In Switzerland and in England all observers seem to agree that it is single-brooded; and this is in direct contrast to the digoneutism of the same insect in New England.

Behavior and flight. The butterfly is particularly fond of fields, gardens, highways, open ground, and waste places; it frequently alights on stone walls heated by the sun, and is greatly attracted by flowers, particularly by thistles and the other plants upon which the caterpillar feeds; here it may readily be taken; not so in other spots, for although very fearless, and even impudent, it is exceedingly wary, dashing off headlong at the slightest alarm. In Florida, Dr. Chapman once found three or four entangled in the leaves of a *Sarracenia*. Lang remarks that in Europe it is very fond of clover fields and in the autumn of ivy bloom. According to Pierce (*Entom.*, xviii: 242) it generally emerges from the chrysalis early in the morning, clinging at first to the old case with its body in a horizontal position and its wings drooping, where it remains until these are dry.

Its flight is rapid, dashing, and discontinuous; it doubles frequently and abruptly, usually to the right or left rather than up or down, although it has no predilection for a particular elevation above the ground, as some other butterflies have; in these frequent changes it makes a series of spasmodic efforts, the movements of the wings being more vigorous during the initial half of each start, or perhaps confined to that period. It loves to return to the spot from which it has been driven, or to the immediate vicinity, often circling about first, as if selecting the best spot. On a windy day its flight is not a little remarkable; it rises high in the air, then suddenly darts down until it has approached within five or ten metres of the ground, when it starts upward again to repeat the process. The strength of its flight is attested by the repeated instances of vast swarms flown from a long distance, to which attention has been directed above. On a warm, sunny day, it frequently flies until within half an hour of sunset, and it may be seen laying eggs at almost any hour between ten and four.

"Its wildly timorous behavior," says Meyer-Dür, "is quite striking; it is uncommonly audacious; swift and savage, it dashes irregularly about; scarcely observing the pursuer, heedless of the net, it returns directly to the place it has left, and sits with horizontally opened wings on the dry earth or spots of sand. It is a nimble, lively, youthful, untamed, petulant insect, which shows in its behavior no resemblance to its proud but circum-spect neighbor, *atalanta*."

On alighting, it partially or wholly expands the wings; when fully spread, they are brought well forward, and are often even slightly

depressed; the straight antennae are then spread at an angle of ninety degrees and lie in the plane of the body, or perhaps slightly elevated.

Enemies. As regards the parasites, *Trogus exesorius* (88:3) has been bred from caterpillars of this insect by Mundt, and Prof. A. E. Verrill has reared a species of *Apanteles*, *A. carduicola*. Mr. Riley has also bred a dipterous parasite, *Exorista blanda* (89:11); its larva usually issues from the victim while the latter is in the caterpillar state, though sometimes not until it has transformed to chrysalis; and in one instance the *Vanessa* completed its metamorphoses with the parasitic fly yet in its abdomen; it did not, however, properly expand its wings. I have seen this specimen and it is indeed a curious one; all the appendages of head and thorax were perfectly developed to their full capacity, but the wings only expanded slightly beyond their pupal dimensions, though with all the markings complete. The appendages of the abdomen (male) are abnormally protruded, and the abdomen itself is completely depressed. Mr. Riley has also bred *Ichneumon rufiventris* Brullé (88:1) from this insect; this hymenopteron issues from the anterior extremity of the chrysalis, infested specimens of which may always be recognized by their pale color. Mrs. Heustis of Nova Scotia found more than half of her chrysalids one summer attacked by this parasite; as well as she could judge (some changes transpiring in the night) all the caterpillars which were attacked were black, and all their chrysalids bright golden. Finally Mr. Riley has notes of an egg-parasite, but no specimens are at hand.

In Europe, the caterpillar is infested by a *Microgaster*; some reared by me perforated the skin of the caterpillar August 19th and made their cocoons on its body. September 4th both dead and living imagines were found, belonging to two distinct species, those of the smaller being dead and dry, those of the larger either living or recently dead; on the succeeding day the remainder of the larger ones appeared, and proved to be, as identified by my friend Mr. Drewsen, of Copenhagen, *Microgaster sub-completus* var.? von Esenb., and the smaller an undetermined species of the same genus, probably undescribed. Of the former three males and fifteen females emerged; of the latter eight males and three females; besides these, four larvae had been taken from their cocoons and preserved in that state; all of these came from the body of a single caterpillar. The larger species is probably the actual parasite of *V. cardui*; the latter, parasitic on the parasite. Besides these it is attacked in Europe according to Bignell and Ratzeburg by a *Pimpla*, a *Limneria*, a *Bracon* and an *Apanteles*; and Dr. Williston tells me that a species of *Tachina* is also parasitic upon it,—making a total in Europe and America of ten hymenopterous and two dipterous parasites. Gentry states that he has found this butterfly in the stomachs of the night hawk, *Chordeiles virginianus*, both old and young, and in those of the chimney swallow, *Chaetura pelagica*.

Desiderata. Cardui is one of the best subjects of study for those who wish to investigate the causes of irregular apparition; and only those who spend much time in the field can hope to solve the problem; a close observation of the comparative abundance of the butterfly for several consecutive years in the same locality, accompanied by the attempt to rear hundreds of the caterpillars, selecting only those which are very nearly full-grown, and recording the proportion of healthy and infested ones, will probably show whether the attack of parasites is a *vera causa*. The hibernation of the chrysalis in America (or even in Europe?) may still be deemed an open question.

LIST OF ILLUSTRATIONS.—VANESSA CARDUI.

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| <i>General.</i> | | Pl. 81:10. Nest. |
| Pl. 21, fig. 1. Distribution in North America. | | 86:69-73. Dermal appendages, stages i-v. |
| 88:1. Ichneumon rufiventris, a parasite. | | <i>Chrysalis.</i> |
| 3. Trogus exesorius, another parasite. | | Pl. 83, fig. 60. Side view. |
| 89:11. Exorista blanda, a dipterous parasite. | | 61. Side view in outline. |
| | | 62. Dorsal view in outline. |
| <i>Egg.</i> | | <i>Imago.</i> |
| Pl. 64, fig. 30. Plain. | | Pl. 2, fig. 1. Both surfaces, colored. |
| 67:7. Micropyle. | | 12:7. Both surfaces, plain. |
| <i>Caterpillar.</i> | | 33:31. Male abdominal appendages. |
| Pl. 74, fig. 37. Mature caterpillar. | | 61:35. Papilla of tongue. |
| 78:61-63. Front views of head, stages iii-v. | | 54. Tongue with papillae. |

JUNONIA HÜBNER.

Junonia Hübn., Verz. bek. Schmett., 34 (1816). *Alcyoneis* Hübn., Verz. bek. Schmett., 35 (1816).

Type.—*Papilio lavinia* Cram

Voyez ce papillon aux couleurs enflammées,
Avec quatre ailes d'or, d'yeux de pourpre semées.
Etre agile, éthéré, folâtre, gracieux,
Promenant en zigzags son vol capricieux,
Il va, revient, repart, monte, descend, tournoie,
Baise, en passant, les fleurs où sa trompe se noie,
Joyau vivant que Dieu, qui l'a colorié,
A de riches fleurons partout amoré.

POMMIER.—*Le Papillon-Espoir.*

Imago (53:8). Head pretty large, rather uniformly and densely clothed with not very long hairs. Front moderately full, a very little protuberant in the middle below, narrower than the eyes, slightly broader than high, above distinctly hollowed in the middle and connected by a shallow channel to the vertex, the upper edge being hollowed in advance of the antennae and projecting strongly forward in the middle, its edges slightly elevated; lower edge pretty strongly and regularly convex, not abrupt. Vertex transverse, rather tumid, with a longitudinal appressed indentation behind and a slight, shallow, longitudinal channel in front; posterior edge of the eyes opposite that of the vertex. Eyes rather large, full, naked. Antennae inserted in the middle of the summit, in distinct slight pits, their interior bases separated by the width of the second antennal joint, their exterior close to the margin of the eye; about half as long again as the abdomen, composed of thirty-five joints, the terminal nine or

ten expanding into a broad ovate, depressed club, two and a half times longer than broad, broadly rounded at tip, the last three joints only entering into the diminution of size. Palpi compact, scarcely more than half as long again as the eye and pretty stout, the terminal joint about one quarter the length of the penultimate, all densely clothed with scales and the apical half of the upper surface of the penultimate with a profuse quantity of pretty long, forward and upward reaching hairs.

Prothoracic lobes pretty large, tumid, scarcely curving at all, larger interiorly than exteriorly and tapering in height more than in length in its lateral extension, more than three times as broad as long and about as high as long. Patagia very little convex, long and rather slender, four times as long as broad, the exterior border nearly straight, the interior curving a little so that the lobe tapers to a point.

Fore wings (38:14) two-thirds as long again as broad, the costal margin very slightly and regularly bowed, perhaps a little less strongly in the middle half; outer margin strongly sinuous, above the middle subcostal nervule slightly convex and at about right angles to the outer half of the costal border, the angle rounded off, then rather suddenly receding at an angle of about 45°, the middle half, as far as the lowest median nervule, forming a broad, rather shallow concavity; the portion below is a little prominent with a well rounded curve, and the inner margin scarcely concave, the angle well rounded. First superior subcostal nervule emitted a little beyond the middle of the outer two-fifths of the upper margin of the cell; second half way between the origin of the first and the tip of the cell; third at about midway between the origin of the second and fourth; the fourth at about three-fifths the distance from the tip of the cell to the apex of the wings. Cell open.

Hind wings with the costal margin considerably and roundly expanded next the base, beyond nearly straight, scarcely convex, the outer angle rounded off; outer border scarcely crenulate, broadly and pretty regularly rounded, except for the slight angular but rounded projection at the tip of the lowest median nervule (♀), or the same but rather flattened in the middle half of the wing and slightly more prominent at the upper angle (♂); inner margin broadly expanded next the base, straight as far as the tip of the internal nervule, where it slopes off rather rapidly nearly to the submedian and continues its course, the angle rounded. Precostal nervule originating at a little distance beyond the divarication of the costal and subcostal nervures, bent strongly outward. Cell open.

Fore legs small, cylindrical, the tibiae less than half the length of the hind tibiae; tarsi about three-fifths the length of the tibiae; the whole leg covered only with scales, excepting in the male where there are a very few short, laterally spreading hairs; tarsi either with scarcely perceptible division into joints (♂); or, largest on the apical third, and consisting of five joints apparent even without denudation; basal joint nearly twice as long as the others together, the next two equal, and as large as the last two together, the terminal minute and bluntly conical; armed beneath apparently at the incisures with an apical pair of very delicate and minute spines, none at the last incisure, those of the terminal joint just at the apex (♀). Middle tibiae very slightly longer than the hind pair; both furnished on either side of the lower surface and on the upper edge of the inner side with rows of infrequent, rather short and slender, diverging spines; first joint of tarsi as long as the three succeeding together; second as long as the third and fourth together, the third and fifth equal and longer than the fourth; first joint with three, terminal with two, the others with four rows of spines beneath, similar to those of the tibiae, the terminal ones of each joint slightly longer than the others; spurs diverging, long and very slender. Claws very small and delicate, compressed, pretty strongly curved, finely pointed. Paronychiae exceedingly delicate, like a slightly curved hair, as long as the claws. Pulvillus minute, tumid, subglobose.

Eighth segment of the abdomen more than usually produced in the middle above, covering the organs, which are more extensively prolonged than usual at this point. Upper organ of male appendages large, the body tumid, roundly arched in both directions, a little compressed; hook considerably longer than the body, the apical half or

third slender, equal, strongly curved; inferior arms joined below the anus, lamellate, turned back completely upon themselves, and furnished at terminal edge with a dense fringe of stiff, straight bristles, in continuation of the lamella, or upward directed. Clasps nearly square, with the upper portion of the posterior edge produced to a long, nearly equal, backward directed, interiorly canaliculate blade, as long as the clasp, which takes the place of the basal process; interior finger long, straight, and very slender, following the course of the blade and nearly reaching the tip.

Egg. Rather broader than high (to judge from specimens in glycerine), broadest in the middle of the lower two-thirds, roundly and considerably tapering above, so that the truncate summit is only half the diameter of the broadest portion, and has a wide area between the termination of the ribs. Vertical ribs few in number, rather slight, strongly compressed; not more than double as high above as below; cross ribs faint, inconspicuous and straight.

Mature caterpillar. Head of moderate size, subquadrate, broader than high, the sides moderately full, broadest at summit of ocellar field, the front appressed, and in the middle even a little sunken, as deep above as below, each hemisphere submammary above, and bearing anteriorly and exteriorly at summit a slightly forward projecting, papilliform, equal tubercle, as long as the width of the triangle; surface smooth, but sparsely covered with papilliform bristle-bearing tubercles of very varied sizes, the largest above, the smallest on the triangle, with similar tubercles crowded on the apical half of the summit tubercle; sutures not deeply impressed, but the hemispheres well separated by a rather deep cut, wider at base than the suture; triangle almost as broad as high, reaching considerably above the middle of the base, the lower border broadly emarginate. Basal joint of antennae hemispherical, second a mere ring, third cylindrical, at least three times as long as broad, and bearing a slender bristle half as long again as the antenna, the fourth joint very minute; the five principal ocelli arranged in a strongly curving row, convexity forward, and the upper much more removed from the others than from one another, forming a third or more of a circle whose centre is just below the sixth tubercle, which is behind the second from the top. Clypeus with entire and straight lower edge; labrum rectangularly and deeply emarginate; mandibles rather small; maxillary palpi rather slender, but normal.

Body cylindrical but tapering gently forwards on the thoracic segments, the first at least of which is smaller than the head, more or less distinctly moniliform, armed with slender, tapering, spiculiferous spines, the body of which is longer than the height of the head, and arranged as follows: a dorsal series, anteriorly placed, on all the abdominal segments excepting the tenth; a laterodorsal series, less anteriorly placed, on all the segments but the first thoracic; a suprastigmatal series, anteriorly placed, on the same segments, but on the third thoracic segment lowered to the stigmatal line; an infrastigmatal series, centrally placed, on all the segments excepting the ninth and tenth abdominal segments, and very small on the third thoracic; a suprapedal, centrally placed, on the same segments, but double on the second and third thoracic and second to sixth abdominal segments. Besides, there are transverse rows of smaller and simpler but otherwise similar, though unequal, spines on the dorsum of the first thoracic segment and the venter of the non-pedigerous segments; and transverse series of minute hair-bearing tubercles on the posterior halves of the segments, and irregularly scattered ones on the anterior halves. Spiracles ovate, with a sharp rim. Legs rather long and slender, of similar length, the last joint compressed, the claw delicate, with a minute basal tubercle; prolegs rather long, gently tapering.

Chrysalis. Viewed from above, the prothorax and head, with the outer edge of the ocellar prominences, taper a little and uniformly; the front line of the body, connecting the tips of the ocellar prominences, is slightly hollowed, with a very slight central prominence; there is an obscure ridge running from the tip of each, inward, toward the middle of the front of the mesonotum. Viewed from the side, the ocellar prominences are well arched, with a minute apical tubercle, the whole being directed forward. Having but a single specimen which has been broken, to describe

from, I can only say that the general direction of the upper and lower edges is apparently in continuation of that of the parts behind, and inclined toward each other at an angle of about 90° ; mesothorax broadly arched longitudinally, not greatly elevated, the anterior two-thirds provided with an equal, rather coarse, median carina. Inferior surface with the appendages straight or scarcely curved; basal wing tubercle, with the two other wing tubercles, much as in *Vanessa*, and similarly pronounced; meso- and metathorax with a pair of central, supralateral, small, conical tubercles, scarcely below the laterodorsal line. Abdomen broadly rounded longitudinally, the curve a little depressed along the middle, provided with a dorsal series of pretty small, equal, blunt, conical tubercles, anteriorly disposed on the second to seventh segments; a laterodorsal series of pretty large, stout, rather bluntly conical tubercles on the middle of the first to seventh segments, that on the first smaller than the others, which are nearly equal; suprastigmatal and infrastigmatal series of very small, scarcely elevated, easily overlooked warts on the fourth to eighth segments, the former placed anteriorly, the latter centrally. Preanal button bounded laterally by scarcely elevated, very broad, curving walls, terminating interiorly in a pair of not very large tubercles, the apical half of which are bluntly conical, and directed forward and downward. Cremaster viewed from above, long and slender, more than twice as long as broad, tapering basally, beyond equal, deeply channelled longitudinally as far as the apical wall, the tip rounded; viewed laterally, nearly equal and slender, curving a little, the very tip expanding, especially on the under side; field of anal hooklets longitudinally oval, twice as long as broad; hooklets pretty long, the stem equal, somewhat curved, moderately stout, the apical portion very gradually and but little enlarged, pretty strongly curved, the apical half of the crooked portion tapering, the pointed tip directed toward the middle of the stem.

This genus occurs throughout the tropics of both worlds, in each of which it is well represented. In the Old World it extends over the whole of Africa south of the great desert, the whole of Asia, at least south of the tropic of Cancer, and all the islands of the Indian Ocean. In South America it probably does not reach beyond the tropic of Capricorn, and, except one species, extends just to the tropic of Cancer in the northern hemisphere; this one species, however (the only one with which we have to deal), is found almost wholly north of the tropics as far as the latitude of 40° , and occasionally a little further. In a few instances it has been taken in southern New England.

The butterflies of this genus are of medium size; the upper surface of the wings bears a general resemblance to that of the *Pyrameis* section of *Vanessa*; the ground color is dark brown often tinged with blue on the middle of the hind wings; the cell of the fore wings is marked by two bright-colored, black-edged, transverse bars; the outer border is edged with clouded, wavy lines preceded, sometimes on both wings, sometimes on the fore wings only, by two ocelli of unequal size in the subcostal and median areas,—the lower being the larger on the fore, the upper on the hind wing; the larger one of the fore wing is also enveloped in a broad, irregular, pale band which crosses the wing beyond the middle. Beneath, the markings of the fore wings are repeated, but the hind wings become clay brown with transverse darker markings, especially in the middle of the outer half of the wing, where they usually include a transverse series of two or more small, dark, rounded spots. The butterflies may further

be distinguished from those of the preceding genera by their naked eyes. The sexes scarcely differ.

The butterflies are at least double-brooded and hibernate in the imago state; the caterpillars live openly upon various polypetalous angiosperms, but especially upon Scrophulariaceae, Acanthaceae and allied families; some also on Amarantaceae, an apetalous plant. The chrysalids hang for a week or fortnight; little is known of the structure or position of the egg, or of the habits of the caterpillar. The butterflies frequent open grounds and delight in hot sunshine; they are strong in flight with the same combination of wariness and daring which characterizes the habits of our other *Vanessidi*, "having," says Bates (*Journ. entom.*, 1864, 193-194), "very little of the floating motion of the typical *Nymphalinae*, and flying near the ground in open, flowery and bushy places." De Nicéville remarks (*Butt. India*, ii: 66) that "they have a rapid flight but seldom go far before settling, which they do with expanded wings often on the bare ground, frequently on flowers."

The eggs resemble in form those of *Vanessa*, and in the fewness of their vertical ribs the *Pyrameis* section of the same.

The caterpillars at birth are unknown; but the mature larvae are provided with shorter spines than those of the preceding genera, and are dark in color with several longitudinal, paler and brighter, equal bands. The head is also crowned by spines, somewhat as in *Polygonia* and other genera.*

The chrysalis resembles that of *Vanessa* but is less prolonged anteriorly and not so tuberculate; it is of a brownish color with dusky shades and more or less mottled.

EXCURSUS XIV.—THE WAYS OF BUTTERFLIES.

His gorgeous plumes were a little worn;
One splendid wing was a trifle torn;
And the season waned. "How can it be
That I stand with my life unliv'd?" said he.
"Heigho!" said the butterfly,
"Would that I knew the reason why.

"Surely I loved the violet pure,
And day by day to her nook obscure
I lowered my glorious wings and quaffed
With a constant mind her perfumed draught.
But how strangely coarse her foliage grows;
Besides,—at that moment I saw the rose.

"I saw the rose, and I knew my fate,
Slow she unfolded; I would not wait,
But prayed and fretted from hour to hour,
Till opened at last the perfect flower.
A perfect flower? That cannot be,
Or how could she lose her hold on me?

"For your rose is burning sweet; in fine
She is over-sweet to a taste like mine;
Too rich, too much, to one who has seen
In a garden beyond, the lily queen.
I saw the lily, and all was o'er,
The rose could reign in my heart no more.

"Creamy white is the perfect hue.
Cold she seemed; with a great ado
I won my welcome. Too late I see
She cannot command the depths in me.
Heigho!" said the butterfly,

"What is it ails each love I try?"

And the season waned. No more he flies;
On a sunflower's bosom broad he lies.
And after all, it is sad, we say,
To think he has thrown himself away;
Could it have been,—the reason why,
That any thing ailed the butterfly?

ELIZA TURNER.—*An Old Butterfly.*

THE butterfly is a daughter of high noon and of the sun. Rainy days see none astir. A few will venture out on a dull day, but it needs the

*Dr. Gundlach writes me that the larva of *J. lavinia*, found in Cuba, has a dark orange colored head, black around the frontal triangle, with lateral spots and coronal tubercles

also black; the body black with lustrous blue spines, white or yellowish points at the incisures, and whitish or yellowish infrastigmatal and macular suprastigmatal bands.

full blaze of the sun to marshall all the hosts ; indeed, there are few butterflies abroad in New England before seven or eight o'clock of a summer's day, and long before nightfall, with closed wings, and antennae snugly packed between, they are quietly resting beneath some leaf or clinging to some grass-blade. The morning seems to be the favorite time for changes, at least with us, whether it be for depositing eggs, their hatching, the ecdyses of the caterpillar, or the assumption of the pupal and imago states. In the tropics, according to Distant, many species have a definite period of the day for their flight, and the esmeralda butterfly, by Wallace's statement, even prefers showery weather for its activities. In resting at night each species has its own peculiar haunts from which it may be easily stirred. Driving one morning within an hour after sunrise across the sandy plains of Nantucket, along a road fringed with a row of stunted pines some fifty feet from the track, a continuous stream of blue-eyed graylings (*Cercyonis alope*) arose, stirred from the low tops of the bordering pines by the rumble of our wagon-wheels ; none were to be seen either before or behind us, but on either side they constantly arose as we reached them, and, wafted by the wind, sank drowsily to the earth. Just before nightfall, at the proper season, one may readily discover the American copper (*Heodes hypophlaeas*) or the clouded sulphur (*Eurymus philodice*), clinging head upward and with drooping wings to any common herbage ; or watching the spring azure (*Cyaniris pseudargiolus*) as it rests on a bough may observe it, as a heavy cloud obscures the sun, drop fluttering to the ground to alight upon a blade of grass in some concealed spot beneath the shrub it had left. Gosse states (*Ann. mag. nat. hist.*, (2) ii : 176) that in Jamaica the Heliconians (*H. charitonia*) assemble in a swarm before sunset and huddle together on the stem of a certain plant for the night ; is it not possible, however, from what we now know of this butterfly, that these were simply males assembling about a chrysalis of a female ?

But we are sending our friends to bed before ever they have busied themselves with the day ! Their first thought appears to be of honey, and off they go, probing every flower they meet, and spending the greater part of the time in this employment. Some butterflies are less greedy than others, and spend long hours in sunning themselves, resting upon the leaves of herbs or trees or perhaps upon the ground, gently half opening and shutting their wings ; many kinds are of a lively and even pugnacious disposition, and perch themselves upon the tip of a twig or on a stone or some such outlook, and dash at the first butterfly that passes, especially if it be one of their own species ; then the two advance and retreat, forward and backward, time and again, circle around each other with amazing celerity, all the while perchance mounting skyward, until suddenly they part, dash to the ground, and the now quiet pursuer again stations himself

on the very spot he quitted for the fray. But they are not always particular to choose one of their own kind for this combat. Toss your hat in the air, and almost any of our angle-wings will dash at it and circle around it as it rises and falls; and the little American copper, one of our smallest butterflies, will dart at every bulky grasshopper that shoots across its field of vision.

Some butterflies are as fond of water, or even of ordure, as they are of the sugared sweets of flowers. Every one must have noticed at the brink of roadside pools left by a recent rain, how the yellow butterflies will start up at one's approach, flutter about a few moments, and then settle down again to their repast. On favorable occasions, you may find them ranged by hundreds along the edge of a puddle, with wings erect, crowded as closely as they can be packed. The little azure butterflies congregate in the same way about moist spots in the roads through woods; but as they choose less frequented places, this is not so common a sight. Our tiger swallow-tails throng about lilac-blossoms, and become so intoxicated that on one occasion a friend of mine caught sixty of them at once between his two hands; and Baron tells the story (*Nature*, xxix : 503) of two kinds of swallow-tails in Madagascar which evidently suck moisture from the ground for the mere pleasure of the thing, alighting by a stream of water and ejecting the water behind as fast as it takes it in in front; on one occasion about a salt spoon of what was apparently pure water was caught from the abdominal flow in about five minutes!

The butterflies I have mentioned show an apparent fondness for each other's company, apart from the attractions of the flowers or the muddy road; indeed, there are very few butterflies which, at the time of their greatest abundance, do not show a tendency to congregate. The monarch, or milk-weed butterfly (*Anosia plexippus*) for example, may be seen quite by himself, sailing majestically over the fields, until late in the season, when, having multiplied to excess, vast swarms are found together; together they mount in the air to lofty heights, as no other butterfly appears to do, and play about in ceaseless gyrations; and sometimes they crowd so thickly upon a tree or bush, as by their color to change its whole appearance; occasionally we hear of the migrations of butterflies in swarms, but they are of rare occurrence, and have mostly been observed in the tropics. Mr. W. Edwards, however, relates how, from the top of Pegan Hill, in Natick, Massachusetts, he saw such a moving swarm flying steadily for hours in a single direction. They passed too high for recognition, although, by his description of their size and their mode of flight, it was probably the same butterfly which we have just mentioned.

The movements of butterflies on the wing are as different as the flights of birds, and just as an ornithologist may distinguish many birds by their mode of flight when their form and colors are indistinguishable, so the

observant entomologist may often determine a butterfly from a considerable distance. In the case of the entomologist, however, the decision is more difficult, since there are such rapid replacements of one species by another throughout the summer that direct comparison of the flight of similar species is often impossible.

JUNONIA COENIA.—The buckeye.

[The buckeye (Behrens); the buckeye butterfly (Maynard); Lavinia butterfly (Harris); the large eyed Junonia (Scudder).]

Junonia coenia Hübn., Samml. exot. schmett., Lep. i, Pap. i, Nymph, vi, Hamadr. B., simpl. 4, figs. 1-4 (1803);—Morr., Syn. Lep. N. Amer. 61-62 (1862);—Scudd., Psyche, ii: 276-277 (1880);—Fern., Butt. Me., 62 (1884);—French, Butt. east. U. S., 200-202, fig. 56 (1886).

Vanessa coenia Boisd.-LeC., Lép. Amér. sept., 182-184, pl. 49, figs. 1-4 (1833).

Papilio orythia Smith-Abb., Lep. ins. Ga., i: 15-16, pl. 8 (1797);—Abb., Draw. ins. Ga. Brit. mus., vi: 30, figs. 30-31; xvi: 8, tab. 28.

Vanessalarinia (pars) God., Encycl. méth.,

ix: 295, 318-319 (1819).

Cynthia lavinia Harr., Hitchc. Rep., 590 (1833).

Junonia lavinia Edw., Syn. N. Amer. butt., 21 (1871);—Middl., Rep. ins. Ill., x: 87 (1881);—Mayn., Butt. N. E., 20-21, pl. 3, figs. 23, 23a (1886).

Figured by Abbot, Draw. ins. Geo. Oemler Coll. Bost. soc. nat. hist., 14;—Glov. Ill. N. A. Lep., pl. 33, fig. 10, ined.

[Not Pap. lavinia Cram., nor Pap. orithya Linn.]

I've watched you now a full half hour,
Self-poised upon that yellow flower;
And, little butterfly! indeed
I know not if you sleep or feed.
How motionless!—not frozen seas
More motionless! and then
What joy awaits you, when the breeze
Hath found you out among the trees,
And calls you forth again!

WORDSWORTH.—*To a Butterfly.*

Imago (14:15). Head covered with brownish white and pale tawny hairs, below and behind the lower half of the eyes with whitish hairs and scales, behind the upper half of the eyes with pale brownish scales, followed by tawny hairs; palpi beneath and on the basal portion of the sides dull white; from the middle of the outside of the middle joint outward a broadening patch of rather pale brown, extending over the whole exposed upper surface, with a few intermingled ruddy scales; apical joint still darker on the sides and above; antennae clay-brown above and on sides, whitish beneath, along the inner inferior surface bare in a gradually increasing luteous stripe, commencing with a broken line in the middle of the basal half, and increasing to the whole width of the antenna at the base of the club; club blackish above, blackish fuscous below, the basal third greenish clay brown above, luteous below, the apical two joints more or less and interruptedly luteous; papillae of tongue (61:30) long oval, not more than half as broad again in the middle as at the ends, four or five times as long as broad, fully as long as half the width of the tongue, the apical rim entire, situated only on the extreme tapering apex of the tongue, in a very open row down the middle of the under side of each maxilla, giving room for several more between each pair.

Thorax covered above with mouse-brown and fulvo-brownish hairs, sometimes with an olivaceous tinge, beneath with brownish white or clay brown, sometimes tinged with vinous; all the legs uniform clay brown, the fore legs perhaps slightly paler; spines black; spurs uniform luteous; claws luteous, growing dusky toward the tip; paronychialia similar to the claws but sometimes blackish; pulvillus black.

Above *fore wings* blackish brown, the broadly sinuous limit of the basal half, a little beyond the last divarication of the median nervure, very heavily powdered

with a lighter tint, usually dark gray brown, sometimes dark olivaceo-luteous; the costal edge nearly to the tip clay brown; the base of the cell, sometimes tinged slightly with fulvous, is crossed by two similar, irregular, transverse bars, twice as broad as long, of orange fulvous, rather broadly edged on the interior and exterior borders with black; the inner is seated upon the median nervure at or a little within its first, and the outer at its second divarication, enclosing the base of the inferior subcostal nervules; between these two bars the cell has dark green reflections; in the outer portion of the wing are two unequal ocelli, the upper and smaller sometimes nearly or quite obsolete, situated in the lower subcostal interspace shortly before the middle of its outer half; when best developed, it is of the diameter of the interspace and is black, with a rather pale blue pupil, and encircled indistinctly with dull olivaceo-luteous; the other ocellus is exceedingly large, its centre in the middle of the outer two-thirds of the lower median interspace, and, when fullest developed, consists of a nearly circular black spot, both above and below, overreaching the limits of the interspace a little, with a pale blue pupil no larger than that of the upper ocellus and a white centre; the spot is encircled narrowly with dull olivaceo-luteous, sometimes with fulvous, and this with a similar circle of brownish black, generally broadest on the interior side; in specimens where the upper ocellus is best developed there is usually in the succeeding two interspaces above, small, vaguely defined, whitish lunules, which, with the ocellus, lie in a line parallel to the upper fourth of the outer border; the wing is crossed beyond the middle by a broad, dull whitish belt, often tinged with clayey brown, broken by the dusky nervules, its inner border very nearly parallel to the limit of the paler basal half of the wing, and including and usually embracing the large median ocellus; its interior border is formed in general of two irregular curves opening outwards, the upper passing from the middle of the costal border to the subcosto-median interspace, midway between the centre of the upper ocellus and the base of the middle median nervule, the other from there to the submedian nervure just before the middle of the outer two-thirds of the inner border, sometimes striking the iris of the large ocellus at the middle median nervule; the breadth of the belt at its upper extremity is less than that of the cell, and the exterior border runs in a nearly straight line toward the middle of the outer border, stopping short of it by less than the width of an interspace, and continuing downward at the same distance from the border to the submedian nervure; beneath the large ocellus the belt is broken, in whole or in part, with dark brown, and the portion in the medio-submedian interspace toward the outer border is more or less tinged with deep orange fulvous; there is generally a tinge of fulvous also in the subcostal interspaces, at an equal distance from the outer border beyond the upper ocellus; two faint, parallel, submarginal, dusky lines follow the course of the outer border, one at less than an interspace's distance from it and the other half that distance, and between the latter and the margin the wing is generally a very little paler; fringe dark brown, interrupted very slightly with white in the middle of the subcostal interspaces, more particularly in the upper ones and to a greater degree in the median interspaces. *Hind wings* of the same general tint as the basal half of the fore wings, but uniform in texture, being of a dark, slightly chocolate brown; at the distance of about an interspace from the outer border there is a slender, crenulate, dusky stripe, parallel to the outer border, followed interiorly by an orange fulvous band, broadest, and of about the width of an interspace, in the middle of the wings, attenuated at either extremity, and not separated from the brown base by a distinct outline; encroaching to a greater or less degree on this colored band, but almost entirely situated in the brown base, are two unequal ocelli, the upper immense, with its centre a little above the middle, and about at the centre of the lower subcostal interspace, consisting, first, of a many-colored, roundish, or generally a little ovate spot, its major axis subparallel to the inner border of the wing, the outer portion generally at least one-half black, the inner orange fulvous, but the middle covered thickly with pale bluish scales (which cover a larger or smaller space, but never more than half the whole spot, and generally more of the fulvous than the black), which appear bluish only over the black, but pearly

over the fulvous, giving to the whole middle a powdery bloom; second of an encircling, rather broad ring of yellowish clay brown, sometimes broader on the inner than on the outer side; and third of a similar, equal, and very distinct ring of black; the whole ocellus usually reaches from the upper median to the upper subcostal nervule, but sometimes extends further above; the lower ocellus is situated in the middle of that portion of the lower median interspace which lies beyond the second divarication of the median nervure; it fills it and is similarly formed to the larger one, its longer diameter at right angles to the costal margin; it usually lacks the fulvous interior and is much smaller than the upper, surpassing only, and scarcely, the middle median nervule; the edge of the outer border of the wing is dusky, and the wing between this and the submarginal streak already described is olivaceous clay brown, more and more infuscated in the upper half, and marked through its middle by a slender, crenulate, dusky streak; fringe dark brown, variegated with pale brown, vinous, and yellowish brown, the darker tints at the nervure tips, the paler at the interspaces.

Beneath; *fore wings* gray brown, more or less tinged with ferruginous, the fulvous bars in the cell of the upper surface repeated more broadly and with the addition of a basal patch edged externally only with black, besides which the base of the lower median interspace and the parts about it are sometimes flushed with fulvous; between the black edged fulvous bars, the cell and the costal border above them are pale gray; the subcostal nervure, as far as a little beyond the tip of the cell, broadly but thinly clothed with rather delicate, recumbent hairs; the ocelli and the broad whitish belt are also repeated beneath the latter, generally a little paler, and extending to the outer and inner border, and thus completely enclose the large ocellus, which not infrequently shows a flush of pale fulvous next the lower outer angle of the wing; as above, the interior border of the pale belt is better defined than the exterior, and is bordered more or less broadly with blackish fuscous; the wing is edged externally with ferruginous, and at about an interspace's distance further from the border in front than behind, is a submarginal, broader, but generally more or less interrupted and crenulate, ill-defined, dusky stripe, heaviest on the medio-submedian interspace; the fringe is dusky, with a darker thread passing through the middle, beyond which, in the interspaces, it is interrupted as above with white. *Hind wings* of the same general tint as the apex of the fore wings, but sometimes a little brighter or darker. In some females it becomes wholly and deeply tinged with vino-ferruginous, but this is generally limited to a straight, transverse, tapering band, with ill-defined borders passing from the middle of the outer half of the costal border toward, but scarcely reaching, a point just above the anal angle, and which includes at its outer border two equal and rather small, circular ocelli, one in the lower subcostal, the other in the lower median interspace; these are often rather obscure, but sometimes bright and distinct, and then occupy nearly the width of the interspace, and are formed similarly to the larger one in the fore wing, except in having usually more blue in the centre; in the interspaces between them and in the upper subcostal interspace, are little brown dots, in a regular series with the ocelli, occasionally in the interspaces bordering the upper ocellus, developing into minute ocelli, patterned after that between them, and then touching its border; occasionally the spot in the upper subcostal only develops in this way; an irregular, crenulate thread of dark ferruginous crosses the wing just beyond the middle, and sometimes marks the limits of the tapering stripe where the latter is broadest; it starts from the costal nervure opposite, a little beyond the middle of the costal border, and passes in a nearly straight general direction (always removed a little toward the base in the lower subcostal interspace, and from the base in the next interspace below) toward the middle or a little beyond the middle of the outer two-thirds of the medio-submedian interspace, where, nearer the submedian than the median, it is bent, with a rounded curve at right angles toward the inner border, and dies out before reaching the internal nervure; it crosses the upper median interspace just beyond its extreme base; within this line, and especially about midway between it and the base, the wing is crossed by a number of slight, more or less distinct, curving, transverse streaks of a similar color; they are particularly to be noticed in the

middle third of the cell and in two small, tapering stripes depending from the costal border, one at about midway between the base and the extra-mesial thread, and the other, which sometimes almost crosses the wing, midway between the first and the latter; at about an interspace's distance from the outer border, but approaching nearer to it at the extremities, and especially next the anal angle, is a regular, transverse, crenulate thread, still of the same color, but often infuscated, the crenulations opening inward in the interspaces; between this and the extra-mesial thread the wing is often a little deeper in tint than elsewhere, even when the transverse band which generally occupies a portion of it is not present at all; and outside of it the wing is paler, a tint which sometimes reaches, with the exception of this thread, to the transverse band; the outer edge of the wing is also ferruginous; fringe generally paler than on the fore wings, especially on the upper half of the wing.

Abdomen above black, covered at base by long, fulvo-olivaceous hairs and on the upper portion of the sides, especially on the apical half, by a few orange scales; beneath, of the color of the under surface of the wings. Appendages of male (33:30): upper organ with the sides of the base of the hook so strongly compressed that a deep triangular hollowing occurs above at the base; apical two-fifths strongly curved downwards, almost at a right angle, slightly tapering as viewed from the side and a little excised beneath next the pointed tip. Clasps very thin, excepting above, broader apically than basally, the posterior edge slightly convex, the superior blade nearly straight, tapering but slightly, rounded at the extremity, both upper and under edges strongly incurved, just before the extremity furnished on the inner side with a recurved, depressed, pointed, falciform tooth and a few downward incurved prickles. Interior finger hidden by the sheath of the blade, scarcely reaching its tip.

Measurements in millimetres. Length of tongue, 10.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	19.5	24.5	27.5	17.	28	30.5
antennae.....	9.5	12.	13.35	7.25	13.	13.75
hind tibiae and tarsi.....	6.5	8.	8.75	5.2	9.4	10.
fore tibiae and tarsi.....	1.8	2.2	2.3	2.25	3.	3.25

Described from more than 30 specimens.

Egg (64:14). Dark green, gleaming; vertical ribs ten in number, strongly compressed, laminate, not very high, increasing slightly in height toward the summit; cross lines very slight and faint and frequent, crossing also the vertical ribs. Height, .56 mm.; breadth, .64 mm.; greatest distance apart of vertical ribs, .16 mm. Described from Florida specimens in glycerine; the height may be too small for nature.

Caterpillar. *First stage.* Head black; body dark gray.

Second stage. Head piceous, the summit of each hemisphere slightly produced to a blunt cone, and all furnished with many very long, black hairs arising from papillae of same color. Body dark gray with sordid white "subdorsal" (Riley) and stigmatal stripes, the tubercles distinctly tapering, almost or quite as high as the length of the segments, yellow luteous, with a preapical fringe of black thorns, a few basal ones and a longer arcuate apical thorn fully as long as the tubercles. Length, 3.5 mm.

Third stage. Head as before but the hemispheres with a distinct tubercle. Body dark brown, the tubercles scarcely tapering, luteo-fuscous, those of the thoracic segments distinctly longer than the others, the apical needles slightly shorter than the tubercles. Length, 5.5 mm.

The above are described from glycerine with some additions from notes by C. V. Riley and W. Wittfeld. The remainder from blown specimens with similar aid.

Fourth stage. Head (78:64) with coronal tubercles black, the papillae luteous or vino-luteous, the hairs black; triangle yellow or orange, infuscated at base. Body brownish, the tubercles blackish fuscous, the apical needle hardly more than half as long as the tubercle. Length, 13 mm.

Fifth stage. Head (78:65) much as in the last, its posterior aspect ferruginous. Body brownish black in general tone, made up of a velvety black base heavily mot-

tled with orange, and along the stigmatal line with purplish gray, forming there a broad band. Tubercles steel blue at base, the lower half of stem dull luteous, apical half blackish fuscous or black, the terminal spinule less than half as long as the tubercle. Length, 22 mm.

Last stage (74: 29, 30). Head (78: 66) as in last stage, but with a metallic brown gloss. Body black-gray, velvety black in a transverse belt at the base of the spines, marked with orange-yellow and orange on the dorsal aspect, arranged in short transverse bars and dots, always surrounded with black; on the sides a maculate double stripe, stigmatal (or slightly suprastigmatal) and infrastigmatal of clay-yellow. All the tubercles with a metallic lustre, a steel blue base and an apex darker than the more or less luteous stem. Stigmata brown with a black rim and a narrow light brown annulus. Length, 32 mm.

Chrysalis (83: 56, 57, 65-67). Head, thorax, legs and wings mostly very pale dull salmon color, all but the wings and the front of the head mottled heavily with pale greenish brown; tongue case dusky green; antennae gray-brown, interrupted narrowly with blackish; wings mottled on the basal half and along upper border with greenish brown and ornamented with a row of small, arrow-shaped black spots in the interspaces, arranged in a row parallel to the hinder border in the middle of the outer three-fifths of the wing, the spot in the lower median interspace much larger than the others and closed behind, enclosing a pale spot; abdomen olive brown in mingled blotches of slightly darker and paler tints, giving it a somewhat variegated appearance under the lens; across the upper portion of the posterior half of the fourth abdominal segment, stretching from spiracle to spiracle, is an irregular, partially disconnected, narrow band of very pale salmon, and across the upper portion of the posterior half of the eighth segment is another similar but unbroken band, both connected together by a narrow, mottled, dorsal band, and the latter broadened by extending over the whole upper half of the ninth segment, except where a pair of oblique blackish dashes cover the surface, running from the dorsal line at the posterior edge of the segment and diverging forward. All the tubercles in advance of the fourth abdominal segment, excepting the dorsal ones, are flanked posteriorly by a roundish cream colored patch; the rest of the tubercle and all the other tubercles reddish with black tips. The abraded surfaces of the abdominal segments are blue gray mottled with brownish fuscous; spiracles blackish bordered with pale cinereous; there is an indistinct, pale salmon, substigmatal, narrow band and a broad but otherwise similar lateroventral band; anterior edge of the head blackish. Length, 17 mm.; height of abdomen, 6.5 mm.; height of thorax, 6.2 mm. Described from a fresh specimen sent by Dr. C. V. Riley.

Another specimen which has been parasitized is quite different, being wholly golden, the tubercles with a slight amber hue; those of the wings a little infuscated. Joints of the antennae marked subapically with a small marginal (on the club submarginal) blackish fuscous spot on either side; tip of the tongue black, previously growing blackish. Along the middle of the outer third of the wings is a row of three black dots placed in interspaces, one posterior, apparently in the medio-submedian, the other two anterior, apparently in subcostal interspaces; and in each of the two interspaces between these two sets a minute wart of the color of the wing; the warts of the suprastigmatal and infrastigmatal abdominal rows are black, and there are besides lateroventral and subventral rows of black spots as large as the warts just mentioned, the former posteriorly placed on the fourth to sixth abdominal segments, the latter centrally placed on the fifth and sixth abdominal segments; a very few blackish dots are scattered irregularly over the abdominal segments. Tubercles of the preanal button black. Cremaster golden; the marginal ridge of the under surface and the middle of the tip of the upper surface black; hooklets dark mahogany. Spiracles concolorous with the body. Length, 25 mm.; of cremaster, 2 mm.; width at basal wing tubercles, 8 mm.; at supernumerary wing tubercles, 8 mm.; at tip of ocellar prominences, 4 mm.

Geographical distribution (21: 2). *Coenia* seems to belong to the

Carolinian fauna, but it occupies also the southern third of the Alleghanian, where it is found in some abundance as far as the annual isotherm of 55° , or even 50° , if not further. To the west it extends across the continent, although it has rarely been reported west of the Great Plains, excepting upon the Californian coast. Southward it extends to the very extremity of Florida (Maynard), and is found sparingly in Cuba, but is in great measure replaced by an allied species. It also occurs along the shore of the Gulf of Mexico at least as far as the Rio Grande (Aaron, Lintner), and has been taken at various points in Mexico,—at San Luis, Alvarez and the Sierra de San Mequilito, all near San Luis Potosi (Palmer), at the Sierra Nola not far from Mexico (Palmer) and at Cordova (Sallé). Eastward it has invaded Bermuda, and west of New England the northernmost points from which it has been reported are the following: Long Island (Graef, Akhurst, Smith), Staten Island (Davis), New Jersey (Andrews), Newburgh, N. Y. (Edwards), Chatham, Ellis, Logan, Stratford and Port Stanley, Ont. (Geddes, Saunders, Moffat, Denton) Dayton, O. (Pilate), northern Illinois (Worthington), Wisconsin (Hoy), and Iowa (Allen, Parker, Osborn). There is a specimen in Geddes's collection taken in the Rocky Mountains, north of our boundary! In the Sierra Nevada, at Summit Station, Baron Osten Sacken took it at a height of 7000 feet, and it is reported from near Truckee, Nev. (McGlashan) and at San Mateo, Cal. (Agassiz).

It is exceedingly rare in New England and I accordingly quote all the captures known to me. In Connecticut, Prof. S. I. Smith has seen several specimens from the vicinity of New Haven, taken the last of September; Mr. E. Norton has taken it near Farmington, and Mr. T. F. McCurdy found the species somewhat plentiful one autumn in the vicinity of Norwich. In Rhode Island, Col. T. W. Higginson reports several from Newport. In Massachusetts, Mr. R. Thaxter has taken it in the western part of the state; Mr. Bennett (according to Mr. C. A. Emery) captured a single specimen at Springfield; Mr. F. H. Sprague took specimens at Granby; Prof. H. W. Parker took two and saw others at Amherst between July 25 and August 4; about Boston it has been repeatedly taken: by Mr. Sprague at Wollaston, Malden, Jamaica Plain and in the city itself, between July 18 and September 18, he having taken or seen nearly a dozen specimens; at Natick by Mr. E. J. Smith, August 17; in Weston and near Newton by Mr. Thaxter; and by Dr. Harris long ago in Milton, August 19. Mr. Sanborn took it in early August on Cape Cod, I took one there on the 12th of that month, and there is a specimen in the Cambridge Museum collected at Taunton by Mr. Pepper. In New Hampshire I took a specimen many years ago at Hampton Beach, on August 12, then the northernmost point at which it had been found; but since then we have Mr. Charles A. Davis's capture of three specimens at Portsmouth,

in 1875 and July 1876, Mr. Thaxter's a little further north at Cape Meddock, Me., July 31, 1874, Mr. Lyman's at Portland, Me., August 11, and even one so far north and east as Bangor, Me., where Prof. Carl Braun took a very fair specimen in July, 1883.

Haunts. The butterfly seems to frequent open grounds, the few New England specimens having been taken in meadows and gardens. Maynard says it prefers dry, hot places; Abbott that it frequents fields near swamps; Sprague, whose experience is limited to New England, that it seems to prefer meadows and low lands to higher ground. Most of the New England captures have been within sight of the sea, where in marshy spots, one of its favorite food plants, the *Gerardia*, best flourishes. I have only seen it close by the sea shore in dry arid spots.

Food plants. The favorite food plant of the caterpillar appears to be *Gerardia purpurea* Linn., one of the *Scrophulariaceae*, on which Abbot represents it as feeding, in the British Museum drawings; but it also feeds, according to the same, on *Linaria canadensis* Spreng. another of the same family. Next to these come the *Plantagos*, it having been found by several persons on *Plantago lanceolata* Linn., and on what was thought to be *P. virginica*, according to Riley; Dr. Wittfeld also found it in Florida, feeding on *Ludwigia alternifolia* Linn., one of the *Onagraceae*.

Larval habits and duration of early stages. According to Mr. Riley the caterpillars spin no web but feed on the outside of the leaf, and in the early stages at least on the under surface, which in devouring they reduce to a skeleton. Dr. Wittfeld's observations in Florida in June and July show that the egg state in the second and third broods lasts about four days, the larval about twenty-five, and that the chrysalis hangs about a week. Abbot's observations of the earliest and latest broods, however, show that in Georgia the chrysalis then hangs fully twice as long, from 15-17 days.

Life history. There are several broods of this species in the south, the butterfly hibernating. At least butterflies are found throughout the winter in west Florida (Chapman), and they have been taken in eastern Florida in February (Burgess, Schwarz), March (Schwarz, Scudder, Palmer) and April (Palmer, Schwarz). The eggs must be laid early in the spring for Abbot records the imago from chrysalis on May 4 in Georgia, and Mr. Atkinson took a female just out of chrysalis in S. Carolina as early as April 8. Dr. Wittfeld in central Florida obtained the imago on June 23, from eggs laid May 18 (probably the second brood of the season in that place), and again on July 16 from eggs laid June 11. Another summer brood is indicated in the U. S. agricultural department notes by caterpillars and chrysalids obtained by Comstock in Alabama the last of August, from which the butterflies emerged the 4th and 5th of September, and Dr. Chapman had one emerge September 9th in Appalachicola. Per-

haps there is still another brood, as in Georgia, by Abbot's notes, a butterfly emerged from the chrysalis, after hanging a fortnight, on October 14, but according to Dr. Chapman the autumn brood does not become numerous until early in October, and butterflies continue to emerge until the middle of that month, and are abundant until November. Doubleday, who observed it in Florida and elsewhere, says it is "two-brooded, the autumnal brood, hibernating, and giving rise to a brood of larvae which are full grown in April, and of which the perfect insect appears early in May." Miss Murtfeldt found parasitized eggs giving out the parasite on August 28 in Missouri, so that it is probable the eggs are laid there about the middle of that month; three were found "deposited at the tips and on the under side of as many leaves" of *Gerardia*.

It is possible that there are two broods at the north; as the butterfly has been found in New England by far most frequently in the latter half of August and in September, there is every reason to believe that here too the butterfly hibernates; and the number of specimens taken and the occasional capture of a July butterfly in a fresh condition suggests that the butterfly sometimes survives the winter, and that the July butterflies are their descendants; of a spring brood, however, there are no signs whatever, the earliest recorded capture being July 18. Probably all the August specimens belong to this brood. It is possible indeed that there is but a single brood, the later fresh specimens being the laggards of a butterfly that has ventured too far north. But it seems to me most probable that all the July and early August specimens are immigrants from further south, and the September brood the only one born in New England, except in its southernmost portions; in that case we must suppose that all the hibernators perish. The fact that a specimen has been taken in July as far north and east as Bangor, where it can scarcely be believed to be indigenous (or it would have been seen again), the absence of a spring brood and the known powers of flight of the butterfly seem to make the migratory hypothesis the more probable; against it there is only the freshness of some of the July butterflies.

Habits, etc. The butterfly has a rapid, strong and enduring flight, and according to Mr. Sprague is fond of the flowers of the golden rod. Doubleday says its flight is "somewhat like that of *Pyrameis cardui* or still more that of *Euptoieta claudia*."

Parasites. A species of *Apanteles*, *A. junoniae*, has been found by Dr. Riley on this caterpillar, and Miss Murtfeldt discovered that it has an egg-parasite, but no specimens are preserved.

Desiderata. It is plain that the sketch given above of the annual history of this butterfly is liable to much modification from future investigation, which we hope may be brought forward at an early day; we can hardly expect to become confident about the New England history of an

insect here so rare without a knowledge of the changes in its history in passing from south northward along the Atlantic coast. Meantime the date and place of capture, sex and condition of every specimen taken in New England should be recorded. Especially are observations needed in southern Connecticut and New Jersey. We have no acquaintance with the flight or postures of the butterfly, nor much with the habits of the caterpillar, or the place selected for the egg; and while we know that it is attacked by at least two parasites, the rest lies in obscurity. We need also better descriptions of the earliest stages and especially the characteristics of the juvenile caterpillar.

LIST OF ILLUSTRATIONS.—*JUNONIA COENIA*.

<i>Egg.</i>		<i>Imago.</i>	
Pl. 64, fig. 14.	Plain.	Pl. 14, fig. 15.	Male, both surfaces.
<i>Caterpillar.</i>		33:30.	Male abdominal appendages.
Pl. 74, fig. 29, 30.	Mature caterpillar.	38:14.	Neuration.
78:64-66.	Front views of head in stages iv-vi.	53:8.	Side view of head and appendages enlarged, with details of the structure of the legs.
<i>Chrysalis.</i>		61:30.	Papilla of tongue.
Pl. 83, fig. 56.	Side view in outline.	<i>General.</i>	
57.	Dorsal view in outline.	Pl. 21, fig. 2.	
65-67.	Side views.	Distribution in North America.	

TRIBE ARGYNNIDI.

FRITILLARIES.

Argynnidi (pars) Steph.; Argynnytes (pars)	Dryades Borkhausen.
Blanch.-Brullé; Argynnidae (pars) Dup.;	Milites (pars) Herbst.
Argynnitae (pars) Lucas; Argynnides (pars)	Perlati (pars) Latreille.
Bruand; Argynnoides (pars) Koch.	Spinosa (pars) Guenée.
Papiliones nobiles Wein. Verz.	

Lo, the bright train their radiant wings unfold!
With silver fringed, and freckled o'er with gold:
On the gay bosom of some fragrant flower
They idly fluttering live their little hour;
Their life all pleasure, and their task all play,
All spring their age, and sunshine all their day.

MRS. BARBAULD.

. . . from their deepest dells
The Dryads come.

J. TAYLOR.

Imago. Head: club of antennae short, subspatulate, very distinctly marked, greatly depressed, scarcely more than twice as long as broad. Palpi large with a bushy mass of often elongated scales, the terminal joint very short, from one-sixth to one-twelfth the length of the penultimate.

Thorax: first superior subcostal nervule of the fore wings arising before the tip of the cell; the second at or somewhat beyond the tip, occasionally a little before it; the third and fourth beyond; cell closed in our genera, and the median nervule connected beyond its second divarication with the vein closing it. Precostal nervule of hind wings originating beyond the divarication of the costal and subcostal nervures; cell closed. Tibiae and tarsi clothed above with spines; terminal tarsal joint furnished

beneath with four rows of spines; fore tarsi of the female usually consisting of five joints and generally furnished with spines as well as spurs, the last joint unarmed.

Abdomen with all the terminal parts largely developed, so that the sexes are readily distinguishable by their means, without denudation. Upper organ and claspers of about the same size, the former large and stout at the base, bearing only a single strongly compressed, downward curved, median, posterior hook. Claspers large and broad, longitudinally extended, tapering only near the tip, the upper process emitted from near the middle of the upper margin, and extending parallel to and often partially covering the extremity of the claspers; it is supported on the interior surface of the clasp by a ridge which connects its base with the lower base of the clasp, often serrated, and then resembling an interior finger; the extreme tip of the clasp generally recurved broadly.

Secondary sexual characteristics. In many cases the branches of the median vein of the fore wing arise from the main stem earlier in the ♂ than in the ♀, as Reakirt first noticed; so in some the vein closing the cell of the hind wing strikes the median vein further out in the ♂ than in the ♀; a row of special hairs is found near the base of the hind wings in some; and finally androconia are present clustered along the veins, particularly the median veins in the outer half of the upper surface of the fore wings; they are always present in all the species of a genus or they are always absent, and are long ribbon-shaped scales, black at base, pellucid beyond, with a lancet-shaped fringed apex.

Egg. Sugar-loaf shaped; flat beneath, more or less rounded above, with numerous prominent, longitudinal ribs, diminishing in number toward the summit and crossed by rather conspicuous cross lines.

Caterpillar at birth. Warts of the body inconspicuous, similarly arranged on thoracic and abdominal segments, and equal; hairs exceedingly long, spiculiferous, tapering, but enlarged at the extremity.

Mature caterpillar. Head not much smaller than the body and not tumid above. Body nearly equal; segments divided by transverse creases into a larger anterior and one or two smaller posterior sections; spines almost fleshy, conical, with sessile, nearly horizontal needles; and arranged in two rows on nearly all the segments on either side of the body, above the spiracles, besides those beneath them; no medio-dorsal row; first thoracic segment without papillae anteriorly, but the upper pair of spines usually longer than any others on the body.

Chrysalis. Head projecting beyond and distinct from the thorax. Superior border of the wings with a secondary tubercle as in *Vannessidi*; dorsum of metathorax pretty regularly rounded, carinate, but slightly the more elevated beyond the middle. Dorsum of abdomen not carinate, but with a mediodorsal row of small and a laterodorsal row of large, sharp, conical tubercles, those of the third segment larger than the others; cremaster short.

General characteristics. This group is composed of butterflies varying from a little below to somewhat above the medium size; their wings, rounded and generally rather elongated, are fulvous and on the upper surface bordered and curiously tessellated in black; beneath, upon the hind wings the fulvous tints are sometimes disguised or supplanted by reddish or greenish hues and they are often beautifully marked with nacreous or silvery spots in transverse curving rows; similar spots occur at the apex of the fore wings. The males are often furnished with androconia which cluster along the veins of the outer half of the front wing above, and are concealed by large cover scales giving the veins a thickened appearance which some entomologists, who do not trouble themselves to

study the *structure* of butterflies, though they may discuss their classification, have wrongly taken as real.* The flight of the butterflies is far less vigorous and has more of the sailing motion than that of the previous groups of Nymphalinae, and they seldom rise to any height.

Distribution. The tribe is common to both the Old and New Worlds; it is most richly represented in the temperate parts of the northern hemisphere, though a few species occur in the warmer districts of Asia, some in the tropics of the New World, and a few also in the temperate regions of South America. It may be worth while here to quote the following passage from Dr. Hermann Behr (Proc. Calif. acad. sc., ii: 176) in which, however, it should be remarked, he uses the generic term *Argynnis* to include, not only the genus of that name as used in the present work, but also *Speyeria*, *Semnopsyche* and *Brenthis*.

I may venture the remark that the geographic distribution of the genus *Argynnis* seems exactly parallel to that of the *Viola*, and not only in occupying the same regnum, but also having the centre of variety and multiplication of species in the very centre of the regnum *Violae*. Indeed we find the greatest variety of the genus *Argynnis* and the genus *Viola* in the northern, temperate and arctic zones; from there they diminish in number, and degenerate gradually in osculant genera, like *Atella* and *Cirrochroa* in the Old World, *Agraulis* and *Euptoieta* in the New. The true *Argynnis* seem nowhere to pass the line, and only far in the southern extremities of America and Australia, where the antarctic representants of *Viola* begin, begin also a few scattered but normal forms of *Argynnis*. We know very well that even the typical species of *Argynnis* are not altogether restricted to the genus *Viola*, but nevertheless there exists an intimate connection between this entomological and botanical genus that makes them not only coincide in their geographical distribution, but shows itself even in the osculant genera of the tropics that feed, as much as we could ascertain, on *Parietales*—that is, on relations of the *Viola* tribes. So *Euptoieta claudia* and *Agraulis vanillae* live in the larva state on species of *Passiflorae*; and we once raised, in Manila, *Cithosia insularis* from a caterpillar we had found on a species of *Blackwellia*.

Early stages and history. The eggs in this group are sugar-loaf shaped with numerous rather coarse, vertical ribs united by somewhat conspicuous, frequent, raised cross lines. They are laid singly, often, apparently, long after the eclosion of the parents, and the caterpillars hatching therefrom never construct nests, nor live in company, generally concealing themselves by day and feeding by night. They are generally very active when they move, but on the other hand many species are subject to attacks of dormancy or lethargy, often in midsummer, which does not appear to affect all individuals alike, some arousing from it at widely different intervals from others. They resemble the caterpillars of the preceding group but, in place of spiny thorns, the body is provided with regular series of rather tapering, fleshy prominences, beset with divergent needles;

* "The males of the large species of the *Argynnidae* have, as a sexual characteristic, a dilatation of one or more of the central rays of the fore wings.... In the order

Orthoptera, the *Achetidae* possess a very similar peculiarity, the ♂ elytron having thickened and serrated rays," etc! Kane, *Europ. Butt.*, 73.

the pair upon the back of the first thoracic segment is very often larger than the others. They feed principally upon violets. The chrysalids are moderately angulated, holding, as it were, a position midway between the preceding and the succeeding tribes. The species are sometimes single brooded, sometimes double brooded or more, and the history of the broods is often more complicated, apparently, than in any other tribe of butterflies, largely due, as it would seem, to the periodic or occasional dormancy of the caterpillar. They generally winter as juvenile, sometimes as half grown caterpillars, rarely or never as eggs, chrysalids, or full grown caterpillars, but perhaps in some instances as butterflies.

Table of genera of Argynnid, based on the egg.

- Vertical ribs very numerous, more than thirty in number.....**Euptoieta**.
 Vertical ribs less numerous, not more than twenty-five in number.
 Vertical ribs generally less than eighteen; egg at most scarcely taller than broad.
 Egg broader than tall, tapering rapidly.....**Speyeria**.
 Egg taller than broad, tapering moderately.....**Argynnis**.
 Vertical ribs generally more than eighteen; egg considerably taller than broad.**Brenthis**.

Table of genera, based on the caterpillar at birth.

- Only two longitudinal series of appendages on either side above the spiracles.....**Euptoieta**.
 More than two longitudinal series of appendages on either side, above spiracles.
 Hairs scarcely slenderer before enlarged tip than at base; two hairs arising from each of the subdorsal warts.....**Speyeria, Argynnis**.
 Hairs distinctly though slightly tapering to enlarged tip; one hair arising from each of the subdorsal warts.....**Brenthis**.

Table of genera, based on the mature caterpillar.

- Spines fully as long as the segments of the body.
 Upper spines of first thoracic segment longer than the rest and distinctly enlarged at tip, the others equal.....**Euptoieta**.
 Most of the upper spines of abdominal segments a little longer than the rest, the others subequal.....**Speyeria**.
 All the spines of upper row equal or subequal, and similar to the rest.....**Argynnis**.
 Spines only about half as long as segments of body.....**Brenthis**.

Table of genera, based on the chrysalis.

- Upper rows of tubercles on the abdominal segments equal.
 Front of head regularly arched between the ocellar ribbons.....**Euptoieta**.
 Front of head laterally tuberculate between the ocellar ribbons.....**Speyeria, Argynnis**.
 Upper row of tubercles on abdominal segments unequal, those of third segment being largest and those of fourth segment minute.....**Brenthis**.

Table of genera, based on the imago.

- Second superior subcostal nervule of fore wings arising beyond the end of the cell.
 Fore wings much produced at tip, costa well arched at base, outer margin except the apex concave.....**Euptoieta**.
 Fore wings not produced at tip, costa scarcely arched at base, outer margin convex throughout.....**Brenthis**.
 Second superior subcostal nervule of fore wings arising before the end of the cell.
 Middle joint of palpi only about one-fourth longer than the longest diameter of the eye....
 Speyeria.
 Middle joint of palpi more than three-fourths longer than the longest diameter of the eye..
 Argynnis.

EUPTOIETA DOUBLEDAY.

Euptoieta Doubl., Gen. Diurn. Lep., i: 168.

Type.—*Papilio claudia* Cram.

... And the busy fans
Among the gayly dressed and perfumed ladies
Fluttered like butterflies among the flowers.

LONGFELLOW.—*The Spanish Student.*

Imago (53:3). Head large, pretty densely clothed with longer or shorter hairs. Front considerably broader than high, moderately and pretty uniformly full, scarcely surpassing the front of the eyes, above uniformly depressed, the middle of the upper border projecting broadly between the antennae and terminating abruptly and squarely in a shallow, transverse channel; lower border well rounded. Vertex very large, about twice as broad as long, very tumid, slightly and uniformly elevated above the upper level of the eye, the posterior border broadly rounded and slightly flattened in the middle, the anterior crowding between the antennae and forming a portion of the shelving channel between them. Eyes pretty large, pretty full, naked. Antennae inserted slightly in advance of the middle of the summit, in deep pits, separated by a space nearly equal to the width of the base of one of them, but connected by a transverse gutter with shelving sides, externally crowded close to the margin of the eyes; considerably longer than the abdomen, composed of forty-three joints of which the last ten or eleven form the club, which is strongly compressed, ovate or subspatulate, increasing gradually in diameter at its origin, very broadly rounded at the tip, the last four joints entering into the diminution of size, scarcely more than twice as long as broad, five times broader than the stalk, the terminal joint with a scarcely noticeable conical tip. Palpi pretty large, scarcely twice as long as the eye, stout, the terminal joint not more than half as long as the penultimate and only clothed slightly with appressed scales; remainder of the palpi very heavily clothed with erect scales, giving it a massive appearance, and also with long, erect, slender hairs upon the upper and lower surface, directed in a vertical plane.

Prothoracic lobes pretty large, straight, tumid, ends well rounded, the outer but little smaller than the inner, four times as broad as long and apparently higher than broad, the upper surface straight and those of the two lobes at right angles to each other. Patagia long and slender, fully three times as long as broad, moderately broad at base, the posterior lobe continued backward as a rather broad, gently narrowing, slightly sinuous blade, minutely subfalcate at the tip, the outer border being a little concave in the middle, convex just beyond, and then nearly straight to the tip, but slightly excised; the inner border has a very broad, gentle curve, slightly sinuous; tip bluntly rounded, exteriorly angulated.

Fore wings (39:4) nearly twice as long as broad, the costal margin broadly convex on the basal third, very slightly and roundly bent in the middle of the basal half, beyond which it is scarcely convex, the apex more rounded, the apical angle well rounded; outer margin with the upper half produced somewhat, rather more in the ♂ than in the ♀, as far as the upper median nervule strongly and pretty regularly convex, below it scarcely concave and directed at an angle of about 45° with the middle of the costal margin; inner margin straight, slightly convex in the middle of the basal half, the outer angle abrupt, scarcely rounded, a little more than a right angle. First superior subcostal nervule arising but shortly before the tip of the upper margin of the cell; the second as far beyond the same as the base of the fourth is from the outer border of the wing; the third nearly midway between the base of the second and fourth; the second inferior subcostal nervule arises two-fifths way down the cell, curved strongly inward at its extreme base; cell but little more than one-third the length of the wing and two and a half times longer than broad; median nervule connected just beyond its second divarication with the vein closing the cell.

Hind wings with the costal margin broadly shouldered, rounded and bent at the extreme base, slightly convex on the basal half, beyond nearly straight; the outer angle a little abrupt, but rounded off, the outer margin pretty strongly and regularly rounded, scarcely angulated in the ♂ at the upper median nervule, the whole margin slightly crenulate; inner margin considerably expanded at the base, beyond a little convex, the apical half with a broad, shallow, rounded emargination, the outer angle pretty well rounded. Precostal nervure curving strongly outward; cell closed. No androconia.

Fore legs small, delicate, cylindrical, fringed on both sides, either with a rather thin brush of spreading hairs (♂), or with only a few hairs on the basal half of the tibiae (♀); tarsi either a little less than three-fourths the length of the tibia, composed of a single joint with scarcely distinguishable subdivisions (♂); or a little more than three-fourths the length of the tibia, composed of four joints, readily seen without denudation, the first nearly twice as long as the rest together, the others nearly equal, each bearing an apical pair of very small, but rather stout and tapering spines, the space between them naked; in addition the first joint bears, beneath, a double row of very small, delicate spines, and a similar spine or two occurs on the under surface of the outer half of the tibia, although tibial spurs are wanting (♀). Middle slightly longer than the hind tibiae, furnished on either side, beneath, and on the upper portion of the inner side with rather irregular rows of somewhat infrequent, rather long and slender, spreading spines, the apical spines of the two inferior rows developed as very long and very slender spurs; besides these the whole upper surface is sprinkled with distant spines irregularly disposed. First joint of tarsi equal to the three succeeding joints together, these progressively shorter, the fourth being three-fifths the length of the second, and the fifth no longer than the third; all the joints, not excepting the apical, furnished beneath with four rows of moderately long and slender spines, the apical spines of each joint slightly longer than the others; above, the tarsi are also clothed with similar but uniform scales, arranged, in a general way, in four rows, less regularly on the basal joint. Claws rather long, delicate, compressed, tapering, on the outer more rapidly than on the basal half, nearly straight until close to the delicately pointed tip, where they are falciform. Paronychial simple, aculiform, exceedingly delicate and slender, scarcely curved, tapering to a fine point, about three-quarters the length of the claw. Pulvillus wanting.

Male appendages of the abdomen: upper organ rather smaller than ordinary, with a pretty long, slender, nearly straight hook, bent downwards and *forward*. Claspers directed upward as well as backward, and thus resembling the Vanessidi, not very long, the upper process short and broad, and developing at its upper posterior extremity a pretty long, recurved tooth, bearing three or four slender spines directed forwards.

Egg. Sugar-loaf shaped, of similar height and breadth, squarely truncate at top, furnished with very many rather coarse and equal, vertical ridges, many of which unite with their neighbors or terminate near the middle, the interspaces broken by unusually distinct raised lines.

Caterpillar at birth. The body furnished with hair-bearing papillae arranged as follows: on the first thoracic segment, just before the middle, a transverse series, of which four are closely crowded on the dorsal portion, the others lower down and separated from them; on the succeeding segments of the body a laterodorsal series just before the middle of the segments, a laterostigmatal series in the middle of the posterior half of the segments, and an infrastigmatal series in the middle of the segments.

Mature caterpillar. Head moderately small, narrower than the body. Body of nearly uniform size, the first thoracic and last abdominal segments only noticeably smaller than the others, distinctly but not strongly moniliform, dark with lighter longitudinal stripes, furnished on either side with three rows of spines, one to a segment in each row, namely: a distant subdorsal, a suprastigmatal and an infrastigmatal row, the last wanting on the thoracic segments, all of equal length excepting the subdorsal spines of the first segment, which are twice as long as the others and

enlarged at the tip. The spines are long and slender, broad at base, attenuated in basal half, bluntly pointed, covered with straight spinous hairs, directed nearly at right angles to the spines.

Chrysalis. Viewed from above, the body in front of the mesothorax is nearly equal, or if anything the head is slightly swollen. The ocellar prominences do not project but are globular; the front of the head, including the anterior portion of the prominences very slightly convex. Viewed from the side, the prominences have the same globular character, entirely without angles, but they project downward a little in their inferior curve; mesothorax rather high, arched, the anterior curve more gradual than the posterior, highest and slightly angulated in the middle of the posterior half, slightly and broadly carinate along the middle line of the whole thorax. Inferior surface with a long and very slight sinuosity, being straight from the base of the ocellar protuberances to near the tip of the wings; basal wing tubercle broadly conical, not angulated, not very high; ridge behind it rather low, but slightly elevated for the supernumerary projection; a laterodorsal series of rather blunt conical tubercles, scarcely as high as broad on the middle of all the thoracic, and the first to eighth abdominal segments; they are very small on the prothorax and first abdominal segment, but otherwise about equal; on the abdomen there is a suprastigmatal series of similar, though somewhat smaller and usually proportionally lower tubercles, a little in advance of the middle of the second to eighth abdominal segments; and a dorsal series of minute warts at the posterior edge of the fourth to sixth segments. Walls of the preanal button coarse, broad, not very high, considerably curved outward in the middle fourth, but otherwise nearly straight, though inclined inwards, each terminating anteriorly in a small, short, rounded tubercle; cremaster viewed from above, very short, triangular, bluntly rounded at tip, much broader than long, the sides extending far back, the bounding walls very broad and not high; viewed laterally, it is as long as it is broad at the base, equal on the basal half, beyond expanding very greatly, especially on the under side; the apical field of anal hooklets is longitudinal, about three times as long as broad, expanding roundly at either end; hooklets not very long, moderately slender, the stem perfectly straight, roundly bent at right angles, the apex tapering to a blunt point and again bent roundly at right angles.

This is a purely American genus, comprising only two or three species, and extending principally east of the great mountain chain common to the two continents, from the tropic of Capricorn to 40° north latitude; one species is common to the whole of the South American part of the district and as far north as Guatemala, where it encounters a second species, *E. hegesia*, which occurs throughout Central America and the Antilles. A third species is found within the limits of the United States, east of the Rocky Mountains, but is abundant only in the southern states. This species certainly differs very slightly from the Central American, though they are generally classed as distinct. I have not sufficient material for proper comparison, but Dr. Gundlach has sent the description of the larva and chrysalis of the Cuban species given in the note,* which feeds on

* *Larva* in general blood-red; on the head there is a black spot on the triangle, another black one above the ocelli, and a third behind the second, yellowish white; on the body there is a subdorsal white or yellowish white stripe on all but the terminal segment, with a black border, interrupted on the middle of each wing, and sometimes within this a brownish line; there is a similar black bor-

dered white stripe just below the spiracles; the first thoracic segment is furnished with a pair of black antenniform clubbed processes, covered with bluish black bristles; the other segments of the body are furnished with a lateral pair of black, bristly spines midway between the white stripes; on the abdominal segments there is another series beneath the inferior white stripe; there is a subventral

Turnera ulmifolia, and which is so different from ours that current opinion seems the more reasonable.

The butterflies of this genus are a little above the medium size, and the colors of the wing are arranged in a somewhat complicated pattern; the basal two-fifths of the wing above is tawny colored and crossed, especially at its outer extremity, by narrow black bands; the distal portions are fulvous, the outer edge nearly black, and preceded by two distant narrow stripes of black, the outer of which, barely escaping the border, encloses a series of small, round, black spots in most of the interspaces; beneath, the fore wing repeats vaguely the pattern of the upper surface, but has its apex marked with brown and hoary hues, separated by an oblique line; on the hind wings similar colors prevail, the hoary tint being mostly confined to a narrow marginal band and a broad extramesial belt, most conspicuous on the upper half of the wings; the submarginal series of roundish spots of the upper surface are repeated faintly beneath.

The species are polygeneutic, but how the winter is passed does not clearly appear from the facts at our disposal; one brood appears very early and another rather late in the season; the larvae feed on various polypetalous angiosperms, preferably *Passiflorae*, and the chrysalis hangs from one to two weeks.

The butterflies frequent open grassy tracts and the rank and tangled vegetation that fringes the border of woods; they frequently settle on flowering shrubs, and, when flying, beat their wings with an irregular, undulating motion, usually keeping near the ground; Doubleday says that the flight of the United States species is rapid; Bates, however, calls that of the Brazilian slow.

The caterpillars are rather slender, with a small, unarmed head; the body is bright, with two longitudinal white bands on each side edged with black, and the skin highly polished or glazed; there is a pair of spines on the dorsum of each segment, those of the first thoracic segment greatly elongated and clubbed; there is also a substigmatal series of short spines on the abdominal segments.

whitish stripe; spiracles black; legs black; prolegs black at the base, beyond rufous.

Chrysalis black, with silvery white markings as follows: a triangular spot at the extreme base of the wings, divided away from the base of the wing into two parallel stripes ending in points, and beside the posterior of which is a rhomboidal spot; a narrow, oblique band crossing the middle of the wing, irregular in breadth, enclosing a black spot and extending over the abdomen as a stigmatal band as far as the penultimate segment; dots on either side of the front, one on the occiput and one behind each of the prothoracic tubercles; there are other dots

scattered over the thorax and a larger one behind the other thoracic tubercles; there is a spot behind each of the subdorsal tubercles of the first and second abdominal segments, and a similar one upon the succeeding segments, but in the latter case confluent with another spot behind the lateral tubercles and enclosing two black points, sometimes distinct, sometimes merged in the ground color; all the silvery spots on the posterior three rings are nearly confluent above; the last segment has no markings, excepting sometimes a ferruginous lustre on the borders; spiracles black; tubercles golden.

The chrysalids are either black with silvery white or nacreous markings, or the converse; they are rather stout but elongated, hardly angulated; the head is squarely cut, with no projecting ocellar prominences, and the gilded tubercles of the back are distant and conical. They are often of very striking appearance, the color being compared by Abbot to "polished mother-of-pearl spotted with gold and black," and Edwards remarking that the pearly surface gives all the colors of the rainbow, while the tubercles are sometimes metallic bronze.

EXCURSUS XV.—THE ORIGIN AND DEVELOPMENT OF
ORNAMENTATION IN BUTTERFLIES.

... But who can paint
Like Nature? Can imagination boast,
Amid its gay creation, hues like hers?

THOMPSON.—*Spring*.

Forever teaching us
The lesson which the many-colored skies,
The flowers, and leaves, and painted butterflies,

Forevermore repeat,
In varied tones and sweet,
That beauty, in and of itself, is good.

WHITTIER.

DOUBTLESS every one is aware that the patterns on the painted wings of butterflies are a sort of mosaic, formed by tiny colored scales, which by varied combinations make the most exquisite designs. The very regular arrangement of these scales may be less generally known; for though mere specks they overlies one another as slates on a roof; and just as figures made by the oblique arrangement of colored slates appear from a distance to have straight and not serrate borders; so, through the minuteness of the scales, markings on a butterfly's wing, which really have ragged edges, appear perfectly uniform.

From this peculiarity of wing adornment a whole order of insects, including those popularly known as moths, millers, hawk or humming-bird moths and butterflies, was named by Linné, *Lepidoptera*—scaly-wings. As a general, but by no means universal, rule, the lowest of these insects fly by night, some which hold a middle rank by twilight, while the highest fly almost exclusively by day. Many of the night or twilight species rest by day in exposed situations, and then cover the hind wings with the front pair, and often the abdomen by both; in such insects the upper surfaces of the front wings are marked with variegated patterns, while the hind wings and the under surfaces of both pairs are usually of a uniform brown color. Even upon the upper surface of the front wings the tints are usually very sombre, bright colors being exceptional among the

moths ; while in the lowest tribes there are many examples of almost uniform drab or brown coloring throughout. To this last statement, however, many exceptions could be given of insects with front wings pictured with variegated designs of such excessive minuteness that their real beauty can be appreciated only when the surface is magnified. So, too, in the large family of *Phalaenidae*, or geometrids, we have moths which often fly by day, and rest with all their wings fully expanded ; and here the hind wings are ornamented as well as the front pair.

It is, however, only when we come to the butterflies, the highest *Lepidoptera*, that we find, as a general rule, all the wings and both surfaces highly ornamented. Even within this group we may see differences corresponding to their relative perfection of structure ; for in the lowest family sombre colors prevail, and in very many instances the under surface is almost uniform in tint ; while, with the sole exception of those butterflies known as swallow-tails, the most variegated and exquisite patterns are to be found in the highest families, and are far more generally distributed among them.

I am not aware that such a direct relation between beauty and rank has been pointed out in other groups of the animal kingdom. There can be no question of its existence here, and in an order of animals at once a synonym for all that is delicate and exquisite it is what should be expected on the theory that the lower represent earlier and the higher later forms developed from a common stock. That complicated or variegated patterns of coloring must have had their source in simpler and less varied designs, and these in slight variations from an absolutely uniform tone of color will not be denied by any who believe in the evolution of complicated structural forms from those of simpler organization ; and must be regarded as possible if not probable by all who study the past life of the globe and see the march of life, with its constant tendencies to differentiation.

It should be borne in mind that, so far as the direct influence of physical agencies is concerned, we are dealing here with a class of facts very different from those we meet in discussing the ornamentation of vertebrated animals. In birds and quadrupeds, the feathers, hair, and other dermal appendages have developed to maturity and even wasted and been replenished under all the vicissitudes to which animal life is exposed during a period of several years. In butterflies, on the contrary, the ornamentation we are considering is confined to the brief final epoch of life, there is no replenishing of the scale-tissue, and the scales are formed rapidly and once for all, at a definite period, viz., immediately upon the change from larva to pupa ; and being then concealed from light and excesses of temperature within a thick integument, and often also behind the walls of a dark chamber of silk, vegetable fibres, or earth, they are as far removed as possible from external agencies. In the depths of this retreat the

scales, including all the pigment of the wings, are completely developed, the insect appearing full-fledged and perfectly caparisoned, subject to no further change.

Nevertheless, the general phenomena of ornamentation in vertebrates are so exactly repeated in butterflies that no one can plausibly claim that these phenomena originate, in the two groups, in distinct proximate causes. Even the same relation of color to locality, which has been so well brought out by Mr. J. A. Allen in various papers upon our native birds and mammals, reappears in butterflies. It would, therefore, seem not unlikely that we shall be forced to discard the idea of direct physical causation in the one case as in the other.

I have seen only a single attempt to trace the origin of the color-patterns of butterflies by the light of modern ideas. This was the subject of a short article by Rev. Mr. Higgins, published some years ago in the Quarterly Journal of Science. This writer maintains that what he terms the primary or fundamental pattern was a "pale ground with darker linear markings following the course of the veins"; and he explains its origin from the earliest monochromatic wing, by supposing that "the scales growing on the membrane upon or near the veins would be distinguished from the scales growing on other parts of the membrane by a freer development of pigmentary matter" within them. From this simple form of linear markings he would derive all those patterns which bear definite relations to the veins, such as the dark bands which cross them at an angle and are scalloped between each pair; thus he says: "a portion of the dark scales begin to diverge on each side from the veins," and "the dark lines thus formed will meet in the middle of the areas between the veins, producing a band of scallops." But all the lighter-colored and more brilliant spots he would derive from modifications in the extent and intensity of the ground-color, or, as he afterward terms it, the "blush."

It will hardly be worth while to follow his line of argument; for, plausible and simple as this hypothesis appears at first glance, it is unsatisfactory. An examination of an extensive series of specimens and illustrations convinces me that an even simpler explanation can be given, in which the darker and lighter markings have a common origin. Moreover there are definite objections to Mr. Higgins's theory. Its basis, that the scales next the veins would have a freer development of pigmentary matter within them, although perhaps true, is a pure assumption, to support which no facts are given. His observations are drawn wholly from butterflies, with no reference to the ornamentation of moths, which naturally would give some clue to the previous simpler condition of butterflies; and finally, if the earliest form of ornamentation were linear markings on a pale ground, from which the scalloped bands were derived, we ought now to find, as one form of variation, transverse series of dark spots *seated on*

the veins; actually, however, while transverse series of dark spots are, next to cross-bands, the very commonest pattern in Lepidoptera, I do not know of a single instance in butterflies, and only one or two in moths, where such spots are seated upon the veins, excepting only such as occur at the extreme margin; such spots, in the body of the wing, are invariably placed *in the interspaces* between the longitudinal veins. The mode of development of eye-like spots, which Darwin has shown to be extremely simple, is also opposed to Mr. Higgins's theory, since these have their origin in a simple dark point in the interspaces, and yet give rise to some of the most brilliant colors possessed by butterflies.

We can hardly hope to obtain a rational explanation of the origin and development of ornamentation in butterflies without studying the color-patterns of the lower members of the same order. This should be our starting-point, since the mode in which the scales originate in the individual precludes, I conceive, all hope of assistance from anatomical or embryological study. We have, indeed, an especial advantage in studying the numerous living types of moths, from the fact that, so far as the hind wings are concerned, all differentiation in coloring has been greatly retarded by their almost universal concealment by day beneath the overlapping front wings. In such hind wings we find that the simplest departure from uniformity consists in a deepening of the tint next the outer margin of the wing; next we have an intensification of the deeper tint along a line parallel to the margin; it is but a step from this condition to a distinct line or band of dark color parallel to the margin. Or the marginal shade may, in a similar way, break up into two or more transverse and parallel submarginal lines, a very common style of ornamentation, especially in moths. Or, again, starting with the marginal shade, this may send shoots or tongues of dark color a short distance toward the base, giving a serrate inner border to the marginal shade; when now this breaks up into one, two, or more lines or narrow stripes, these stripes become zigzag, or the inner ones may be zigzag, while the outer are plain—a very common phenomenon.

A basis such as this is sufficient to account for all the modifications of simple transverse markings which adorn the wings of Lepidoptera, and explains why, amid all the profound modifications the color patterns have undergone, the transverse style of markings holds a fundamental position; and why such markings are far more prevalent on the outer than on the basal half of the wing, and are also so frequently scalloped. All the steps of this process, as I have explained it, apply equally well to the front wing, excepting that we cannot there so well trace the initial step in the differentiation of the primordial uniform coloring.

To carry this theory another step: By the breaking up of any one or more of these bands into spots or bars, we may conceive two new forms

of pattern according as the break occurs in the interspaces or at the veins. In the former case, the tendency of dark scales to cluster along interruptions of any nature in the surface, whether veins, folds, creases, or margins, together with the concentrating force presumed in a rupture of the band, will be sure to cause the scales to collect along the veins, and, uniting with similar spots upon them, to border the vein on either side continuously. This will map the veins very distinctly upon the ground, producing in fact that condition of things which Mr. Higgins considers the primary pattern, but which, certainly, we rarely find in moths and not very commonly in the highest butterflies. Indeed, when carried to an extreme, as in the dark-veined insects with otherwise diaphanous wings, we find it only in some of the very highest moths (*Aegerians* and *Sesiadae*) or butterflies (*Heliconians*). The junction of these darkened veins with the darkened border of the wings produces, I suppose, the series of spots upon the tips of the veins which sometimes occur there, but, as already stated, on no other part of the veins.

If, on the other hand, the break be supposed to occur at the veins themselves, then the tendency would be to form short transverse bars, or quadrate or more or less rounded spots in the interspaces; and, finally, by a differentiation of the exterior and interior portions of a round spot, a more or less perfect ocellus would be formed. Occasionally we find long streaks of dark color down the middle of the interspaces, similar to those along the veins, produced, no doubt, by the frequent presence of a crease in such places, and the tendency of scales to follow it; the comparative weakness of such breaks in the continuity of the membrane is the reason of the comparative rarity of this form of ornamentation. The formation of ocelli has been shown by Darwin, who traced, in specimens of a South African butterfly (*Cyllo leda*) a perfect gradation "from excessively minute white dots, surrounded by a scarcely visible black line, into perfectly symmetrical and large ocelli"; and instances are common in our own butterflies where one can follow a similar series onward from a uniform circular dark spot. First, a central white dot appears in it; next the whole is encircled by a light-colored halo, and so on. Darwin mentions one moth with a magnificent ocellus consisting of a black centre with eight concentric zones of colors.

Ocelli not infrequently surpass the bounds of the interspace in which they originate, but among the hundreds of ocellate specimens examined with this point in view, I have failed to find a single ocellus of a simple character which could not be definitely referred to some particular interspace. But there are other ocelli, of a complex character, such as those of the peacock butterfly of Europe (*Inachis io*), where, assuming it had a similar origin, we cannot possibly say where it belongs; but in this butterfly, the other markings of the wing are seen directly through the ocelli, as through

a veil ; and I believe they can be shown to have arisen in an entirely different way, by an alteration in the relative position of certain bars and spots common to butterflies of this group. No doubt all other complex ocelli, such as those with spiral annuli, could be shown, upon special study, to have originated in some similar manner.

After reaching such a stage of complication, and assuming the known tendency to suffusion of markings in butterflies, that is, the blending of neighboring spots, we may easily see that, by the amalgamation of adjoining spots in different transverse rows, every conceivable pattern can be explained. There is nothing left to consider but the diversity in color itself ; and observation shows that although there are prevailing tints as well as prevailing patterns in special groups of butterflies, that nevertheless these colors are often very pliable ; for instance white, yellow, and orange are readily interchangeable ; and a similar reciprocal relation exists between orange and red, or between certain tones of yellow and brown.

Again, when we compare individuals of the same species, especially if of opposite sexes, the great difference between them in the profusion with which scales of metallic blue are sprinkled upon a normal dark ground shows how easily black or dark brown is replaced by metallic blue ; the latter again is readily interchangeable with metallic green, or with purple or ordinary blue or green. Some instances of this interchangeability are given elsewhere, and it is not therefore worth while to dilate upon it here. It should, however, be stated that the iridescence on the wings of many butterflies is of an entirely different nature, being due to a microscopic striation of the outer surface of the scales.

The hypothesis, then, of the origin and development of color-patterns in butterflies which I would maintain is based upon the scale of complication seen in the markings of living *Lepidoptera*, and the prevalence among them of certain general patterns. According to it, the wings first showed signs of divergence from uniformity by a deepening of the color next the outer margin, which thereafter became separated into distinct transverse bands ; these bands, in breaking up, gave rise to dark-veined or to spotted wings, which served as the basis for all the variegated patterns of the present day, including ocelli, which are only specialized forms of simple interspacial spots.

This discussion leads naturally to the consideration of the intimate connection between the color-patterns and the frame-work of the wings in *Lepidoptera* ; this relation, indeed, must be considered one of the most important features in the topography of the wings, if I may use the expression. It is seen with the first appearance of ornamentation, in the wavy outline of the transverse bands, each wave corresponding to the position of the adjacent veins. It is still more conspicuous when these bands break up into bars or spots. But its full force is shown when the

patterns become most complicated, where, indeed, we should naturally expect that ornamentation would be least restrained by such limitations. The rod-like veins of the wing are often completely concealed beneath the downy covering of scales, and yet there is scarcely a spot in the wing of any butterfly whose precise position is not fixed by the nearest veins. This, however, is a very imperfect statement of the facts; to consider them fairly we must recall the general structure of the wings in butterflies. These consist, as explained more fully in the Introduction to this work, of a thin double membrane supported by tubular rods, which extend between them and diverge somewhat like the rods of a fan. In butterflies, the number and distribution of the main rods or veins are essentially the same in the front and hind wings, although the wings themselves differ greatly in shape. Omitting details, there is a single unbranched vein in front and another behind; while between these are two others, both branched, of which the front one (the second vein of the wing) throws out branches on both sides and the other only behind. This distribution of the veins may, for our purpose, be considered as dividing the wing longitudinally into four separate areas, each occupied by a distinct vein with its branches. The principal difference between the two wings is found in the branches of the second vein; in the front wing the anterior branches are numerous and most of them run to the front border of the wing; this arrangement is plainly for greater strength, the front edge of the fore wings having to bear the brunt of flight, while the front edge of the hind pair requires no such special provision, these wings in flight being practically a part of the front pair; and they therefore have only a single front branch to the second vein terminating on the outer margin.

Notwithstanding these great differences, but in harmony with the fundamental idea in articulated animals that similar parts on successive rings should have similar structure, the markings of the two wings harmonize even to a greater extent than appears at first glance; for although there is a distinct tendency toward symmetrical repetition of markings upon the front and hind wings of a butterfly, this symmetry is not absolute, being subordinated to the distribution of the veins, and this again to the diverse needs of the two wings. The distribution of spots on these wings may therefore appear very different, when in reality they hold the same position on both, *relative to the structure*.

The number of instances in which similar markings appear in the same areas of the two wings, and in the same relative position in those areas, is far too common to be a mere coincidence; it is most readily traced in the disposition of ocelli, which are very apt to be similar in size and perfection and to be situated between the same branches of homologous veins. As one of a thousand examples of this kind, the peacock butterfly may again be cited. On the front wing of all the butterflies of this type, the

basis for a complex ocellus exists, as already remarked, in the disposition of the bars and colored patches in the subcostal area, or the area of the second vein; in the peacock butterfly such an ocellus is formed and extends to the front margin of the wing, because the subcostal area reaches that margin. On the hind wings of these butterflies almost the only element for the formation of an ocellus is a short bar in the same area resembling one on the front wings; yet from this a complex ocellus, not so imposing as that of the front wings certainly, but still a marked ocellus, has been formed; which, true to law, just fails of reaching the front margin, keeping within the normally narrower limits of the subcostal area of the hind wing.

This distribution of the veins enables us also to point out an interesting relation between the ornamentation of the front and hinder portion of a single wing, which seems never to have been noticed, and which shows again both the strength and the weakness of symmetry. The relation of the ornamentation of the hind to the fore wing is not one of slavish repetition; indeed our ingenuity may often be taxed to discover it. But the relation of the two parts of the same wing has even less of repetition; for to a certain extent there is a polar distribution of markings. For instance, there is often a bright-colored ocellus at the inner angle of the hind wing, in the area of the fourth principal vein; should a single similar ocellus, or a bright-colored spot corresponding to it, occur in any other part of the wing, *there is only one place where it will fall*, viz., at an exactly corresponding position in the area of the first (i. e., the other unbranched) vein of the wing, as may be seen in *Euphœades troilus*. I do not mean there will be a corresponding spot, for one often occurs in one of these positions and fails in the other; nor that there may not be similar spots in all the areas; but that if there is a brilliant spot in the area of the fourth vein, and only one other similar spot elsewhere, the latter will fall in the area of the first vein. This is the more curious, because I do not discover the same polarity in the repetition of markings in the areas of the branching veins; here repetition is frequent, but it is far more common to find similar markings between the hinder branches of the one and of the other, or between their front branches.

Can such a play of plan in ornamentation, affecting more than our mere sense of beauty, awakening indeed in us an intellectual pleasure which does not rest upon the surface of things as a purely sensuous appreciation must do—can this be explained as purely for the purposes of the ephemeral creature itself? If it cannot; if, for instance, it is of no advantage to the butterfly that its second brilliant ocellus should occur in the area of the first rather than of the second vein, then it cannot have arisen through natural selection, without the guidance of a higher law, which has other ends for beauty than the mere survival of the creature possessing it.

The relation of the markings to the areas is still further shown in a curious way. Transverse markings, as has been said, are a predominating feature of butterfly ornamentation. If in the transverse markings of the outer part of the wing, there is a break, a sudden shift of direction, a removal, perhaps, of a fragment of a band to one side; such a change invariably takes place, I believe, at the line of demarcation between the areas, or at one of the immediately adjacent veins; never within the limits proper of any one area. On the front wings of the lowest butterflies we frequently find a submarginal band of spots, of which one or two are situated in the space between the adjacent branches of the second and third veins. The continuity of this otherwise uniform band is almost always broken by the shifting of these particular spots a little toward the margin of the wing. This is a single instance of which very many could be given.

It will be seen then that the relation of the markings of the wing to the disposition of the underlying framework is an important one, and actually seems to increase in importance with the complexity of the ornamentation; so that the study of the diversity of patterns becomes an intellectual pleasure. Indeed my first appreciation of this relation arose from the necessity of carefully describing these markings for the present work; it was not until the minute examination which this required had forced it upon me that I learned how subservient is ornamentation to the requirements of structure, or how much reflex light was thrown by mere color patterns upon the very plan of structure itself.

In all that has been said I have only attempted to trace the probable lines along which ornamentation increased in complexity. Causes I have purposely left in the background, although I have here and there intimated that I do not believe change is wholly due either to the action of physical agencies or to natural selection. That each of these forces has born its part in the work, there can, I think, be little doubt; but in a case like this, where we find beauty of the most exquisite and refined character in creatures of an inherently low organization, I can only express a deep-seated conviction that a preordaining purpose and plan governs these proximate causes, and that beneath both structure and beauty we may discern far-reaching and controlling thought.

And here I cannot do better than translate the following passage from Werneburg, first read after the above essay was written. "When we consider," says he, "the variety and in many cases the remarkable splendor of color which is not only peculiar to Lepidoptera in a far higher degree than to any other group of insects, but which is also displayed before the eyes of the observer in a remarkable way; and when we further remember that in many cases the color is not of the slightest use to the creatures themselves, but rather of disadvantage by its lustre and brilliancy,

we cannot forbear to enquire into the meaning and purpose of such a phenomenon. And here I at least am unable to find any other reply than this: that the beauty of butterflies serves to enliven and embellish, and thereby, like all other beauties of nature, to do its part in the cultivation of the human mind and heart. With this view agrees the fact that it is precisely those that fly by day, when man is most in the open air, and beauty can be the more readily observed, that are the most beautiful; and the further fact that their colors, on the upper surface, as that which presents itself most prominently to the eye, as a rule *contrast* with the objects on which they settle or about which they flutter, by which means the effect is decidedly strengthened, and by which they are essentially distinguished from those Lepidoptera that fly by night, where the exact opposite is generally true." (Der schmetterling und sein leben, 115.)

EUPTOIETA CLAUDIA.—The variegated fritillary.

[The variegated fritillary (Gosse); pale red butterfly (Maynard)].

Papilio claudia Cram., Pap. exot., i: 109, pl. 69, figs. E. F. (1779).

Dryas fucata claudia Hübn., Samml. exot. schmett., i. Lep. i, Pap. i, Nymph. iv, Dryad. B, fuc. a, figs. 1-4 (1806).

Brenthis claudia Hübn., Verz. schmett., 30 (1816).

Argynnis claudia Doubl., Catal. Lep. Brit. mus., i: 67 (1844).

Euptoieta claudia Doubl.-Hewits., Gen. diurn. Lep., i: 170 (1848); — Chen.-Luc., Encycl. hist. nat., Pap., 90, fig. 192 (1853); — Edw., Can. ent., xii: 231-235 (1880); — French, Rep. ins. Ill., vii: 150-151 (1878); Butt. east. U. S., 165-168, fig. 43 (1886); — Middl., Rep. ins. Ill., x: 80 (1881); — Fern., Butt. Me., 44-45 (1884); — Mayn., Butt. N. E., 21-22, pl. 4, fig. 24, 24a (1886).

Papilio clausius Herbst, Natursyst. ins. schmett., ix: 189-190, pl. 257, figs. 3-4 (1798).

Papilio daunius Herbst, Natursyst. ins. schmett., ix: 184-185, pl. 256, figs. 1-2 (1798).

Papilio mariamne Abb., Draw. ins. Geo. Brit. mus., vi: 31, figs. 36-37; xvi: 29, tab. 65. (ca. 1800.)

Argynnis columbina God., Encycl. méth., ix: 252, 260 (1819); — Boisd.-LeC., Léop. Amér. sept., 153-154, pl. 44, figs. 1-4 (1833); — Morr. Syn. Lep. N. Amer., 44 (1862).

Figured by Abbot, Draw. ins. Ga., Gray Coll. Bost. soc. nat. hist., 51; Oemler coll., ibid., 11; — Glov., Ill. N. A. Lep., pl. 1, fig. 10; pl. 36, fig. 1, ined.

[Not *Papilio columbina* Fabr.]

Some finished butterfly,
Some breathing diamond-flake with leaf-gold fans,
That takes the air, no trace of worm it was.

BROWNING.—*The Ring and the Book*.

Imago (14:4). Head covered profusely with pretty long, loose, delicate, dark olivaceous, fulvous and blackish hairs, which form also lateral tufts upon the basal four or five joints of the antennae; sides and under surface covered with fulvous and black scales, excepting a border of white scales next the posterior and lower portion of the eye, which broadens below and sometimes occupies nearly the whole of this part of the head, to the almost complete exclusion of the fulvous scales; palpi with the basal joint white, the middle joint white beneath, on the lower half externally and the basal half of the middle internally; the rest and the apical joint foxy fulvous, mingled with blackish, hair-like scales, the inner surface paler; bristles of the inferior fringe black when they issue from a white base, or fulvous when they do not; antennae dark luteo-fulvous, heavily flecked above with very minute blackish scales,

which become blackish brown on the middle half, enlivened with a few fulvous scales, especially on the basal third externally, all the joints above marked delicately with pale castaneous; basal third beneath heavily covered with whitish or yellowish white scales, which continue externally nearly to the club, as a slender line; here they expand again, forming a large, triangular spot of dull whitish scales on the outer surface, excluding the apical four or five joints; club above dark brown on the basal, castaneous on apical half of the joints, the middle third next the whitish scales covered with blackish scales, beneath a little infuscated; the terminal four or five joints naked or nearly so, and above much paler than the rest, inclining to luteous; tongue luteous, infuscated above for the length of the first coil, beyond black at the sides, above paler, the tip blackish fuscous.

Prothoracic lobes covered with long hairs like those of the head, rest of thorax above covered with long fulvo-olivaceous hairs, perhaps slightly darker on the patagia, frequently mingled with some brownish hairs; beneath covered with pale vinous and pale grayish hairs and pale scales; forelegs of ♂ covered above with fulvous hairs, paler on the tarsi; of ♀ fulvous above, whitish below, the tarsi all pale, tinged with fulvous down the front of the upper surface; femora and tibiae of other legs above fulvous, sometimes deep fulvous on femora, beneath white. tarsi testaceous, often flecked to a considerable extent above with white scales; spurs luteo-testaceous; spines black; claws luteo-testaceous; paronychiae pale, nearly colorless.

Wings above pale fulvous, tinged slightly with orange, excepting in a broad, common, mesial band, marked with black and blackish fuscous, the veins, excepting the base of the median, blackish fuscous. Basal half of *fore wings* a little deeper in tint than the rest of the wing, and lightly powdered with brownish, giving it a slight griseous aspect, limited exteriorly by a connected, very irregular, strongly dentated, transverse stripe of medium width, running from the costal border to the submedian nervure; it starts from scarcely beyond the middle of the costal border, and runs to the lower subcostal nervule, in an obliquely placed curve, the lower half more bowed than the upper, striking the lowest subcostal at about the middle of its basal half; in the subcosto-median interspace it leaps outward, its inner border being usually beyond the outer border of the previous and succeeding part of the band, while in the median and medio-submedian interspaces it passes by successive, more or less oblique, subparallel bars, bent outwards, particularly on the lower half or two-thirds of each, which are placed successively nearer the base; that in the upper median being as a whole in continuity with the subcostal portion of the stripe; that in the lower median starting from a slight distance beyond the origin of the middle median and from about half an interspace's distance within the termination of the previous bar, and terminating at about the middle of the basal two-thirds of the lower median; that in the medio-submedian bearing the same relation to the lower median as that does to the upper median bar, but usually less oblique, and terminating scarcely beyond the middle of the submedian; these bars are almost always connected by slender, recurrent stripes traversing the nervules almost longitudinally; where this mesial stripe touches the costal border it is often vague and dispersed, making the whole of the outer half of the basal half blackish fuscous; the extremity of the cell is marked by a transverse, prominent bar, following and covering the veins, and the cell itself is crossed by two similar bars, the outer connected above and below with the exterior bar, and so enclosing between them a transversely suboval, very pale fulvous spot, its shorter axis about twice as long as the breadth of the bars, the inner crossing the middle of the cell, often not attaining either nervure, and generally crescentic, opening inward, its lower extremity opposite the origin of the lowest median nervule; in the medio-submedian interspace is a bent, transverse bar opening inwards, starting above at the origin of the lower median, and having its angle produced so as often to touch the mesial stripe; beyond the mesial stripe, and separated from it by a width of from one to two interspaces, is a transverse, connected, blackish fuscous streak or stripe, originating above in a longitudinal, triangular, blackish fuscous spot, seated with its broad base upon the costal margin, from the tip of the costal nervure to a

little beyond the last divarication of the subcostal, and extending to the middle of the next to the lower subcostal nervule; from here it passes subparallel to the outer border in a series of transverse, slender bars, successively nearer the base of the wing, to the submedian nervure, which it strikes at a little less than midway from the extremity of the mesial stripe to the outer border; on the upper median nervule the extremity of the upper median bar touches the extremity of the mesial stripe, thus dividing into two subequal parts the rather irregular, broad, very pale fulvous, mesial band formed between these two stripes; beyond this band the ground color of the wing is usually of the same depth and brightness as before it, and it is crossed by another submarginal blackish stripe, subparallel to the outer border, removed from it by from half an interspace (below) to one and one-half (above), and formed of a series of shallow curves in the interspaces, opening inwards, and most bowed in the lower subcostal region; at the costal border this stripe, too, expands into a triangular spot, which often merges into the one previously mentioned and into the blackish outer border; midway between this stripe and the extra-mesial stripe is a series of roundish oval, transverse, medium sized, equal, blackish spots in the lower two subcostal, median and medio-submedian interspaces, occupying more than half the width of the interspaces, the lowest approximated to the submarginal stripe, and sometimes confluent with it; occasionally a dot occurs, also, in the subcosto-median interspace; the outer border is bordered with blackish or blackish fuscous in a variable degree, sometimes encroaching so far on the submarginal stripe as to leave only slender, fulvous lunules between them (most commonly in the ♀), or reduced to a narrow edging no broader than the submarginal stripe (most commonly in the ♂), but in all cases broadest upon the nervules; fringe white, broadly interrupted with blackish fuscous at the nervure tips, and generally flecked throughout on the basal half with blackish brown. *Hind wings* generally a very little deeper in color on the basal half than either fore or hind wings are elsewhere; and broadly flecked with blackish fuscous scales along the median nervure; an infra-mesial, rather slender, sinuous, blackish stripe crosses the wing; starting from a very little beyond the middle of the costal border, it passes in a curve opening outward to the middle of the basal half of the upper subcostal nervule; from here in an opposing curve to the middle of the lower subcostal interspace, a short distance from its base, hence in a straight or nearly straight line to the middle of the basal curve of the upper median nervule, is here bent at nearly right angles toward the inner border, and passes to the medio-submedian interspace in a slightly irregular course, generally scarcely broken at the middle median nervule; a crescentic, transverse bar, opening inwards, crosses the extremity of the cell, nearly connecting the base of the middle subcostal and lower median nervules; beyond the infra-mesial stripe is a broad, very pale fulvous, bowed band, much more regular than that of the fore wings, and about one and one-half interspaces in width; it is bounded externally by a slender, blackish fuscous, extra-mesial streak, bent and broadest in the lower half of the subcosto-median interspace, but otherwise nearly straight, tapering toward either extremity, and often fading out altogether before reaching either border. Beyond this the markings are an almost exact repetition of those of the fore wings, with the sexual distinctions, excepting that the nervures of the hind wings are also accompanied more or less by blackish fuscous scales, nearly or quite as far as the extra-mesial band in the ♀, and that the roundish spots are almost always circular, occur only in the subcostal and median interspaces, the upper subcostal reduced to a mere dot or even wholly obsolete; as in the fore wing, there is also occasionally a dot in the subcosto-median interspace; fringe as on fore wings.

Beneath, *fore wings* orange fulvous on the basal half with the blackish markings of the upper surface repeated with diminished vigor, the two outer bars of the cell divaricating from below upward, not uniting nor even approaching above, the enclosed spot white or whitish fulvous; the broad mesial band is pale straw color and ill-defined, since the extra-mesial stripe is wanting; in its place, above, is a silvery white triangular spot, largely flecked with brown scales, especially along the costal margin and next the mesial band, and in such places often tinged with a very faint greenish

blue, giving it a hoary aspect (sometimes reaching across the mesial band to the intra-mesial stripe) extending on the costal border from midway between the tips of the second and third superior branches of the subcostal to the mesial band, and to the middle of the outer four-fifths of the lowest subcostal nervule, its outer limit well defined and nearly straight; when, as occasionally, it includes the upper portion of the mesial band, it extends downward to the upper median nervule. Midway between this and the outer border, there is usually another vaguely defined whitish spot occupying the whole width of the lowest subcostal interspace, sometimes shading off very gradually toward the tip of the wing, which is generally of an ochraceous hue and between which and the triangular silvery spot is a fusco-fulvous stripe, often tinged with olivaceous, broadening downward, extending from the costal border to the lowest subcostal nervule; the same color is repeated next the outer border in the subcosto-median and upper median interspaces, limited inward by a dark fuscous, slender, submarginal stripe, less than an interspace's distance from the outer border, and which reaches nearly to the inner border. In the median area the outer half of the wing is fulvous, not so deeply tinged with orange at the base, and, corresponding to those of the upper surface, are three roundish black spots in the median and medio-submedian interspaces; a blackish fuscous line traces the limit of the outer border; fringe blackish brown, interrupted rather broadly with dirty pale yellowish in the interspaces. *Hind wings* luteo-tawny upon the basal two-fifths, strongly enlivened with dark brownish ferruginous, especially in the upper outer half of the area, collected to a considerable extent into minute blotches or flecks and besprinkled lightly with blackish and silvery white scales, the former in the upper, the latter in the lower half of the wing; in the upper half of the wing the basal colors are distinctly limited, the line of demarcation following that of the infra-mesial stripe of the upper surface, excepting in the subcosto-median interspace, where it is removed considerably towards the base, and crosses the cell in a strong curve, opening inwards, whose outer limit does not reach the middle of the vein closing the cell; in the costo-subcostal interspace there is a strongly curved, transverse streak of white, or grayish white, usually enlarged considerably at either extremity, its lower end resting on the first divarication of the subcostal; and in the medio-submedian, next to the first divarication of the median, a transverse, often bent, black streak, between which and the limitation of the basal color (which in this part of the wing is marked by an independent though faint, intra-mesial, blackish streak) the color is paler frequently forming a broad pale band extending nearly to the inner border; the costal margin is traversed throughout its length by delicate transverse streaks of blackish brown; beyond the basal two-fifths is a very broad mesial band similar to that of the upper surface, but usually broader, of silvery or grayish white above the subcostal nervule, below it pale brownish white, more or less flecked with very short, minute, transverse streaks of blackish and ferruginous, generally more frequent on the outer half; the outer border is broadly bordered with hoary, flecked somewhat with dark brown, averaging fully half an interspace in width, but tapering to a point at the costal and submedian nervures; the inner border is not regular, but mounts inward above and upon the lower two subcostal and upper median nervules; between this border and the mesial band is a broad band of fusco-ferruginous, or dark fulvous, deepest in color above, and flecked minutely with transverse blackish lines, and enclosing in the middle of the lower subcostal and the median interspaces roundish blackish spots half as broad as the interspaces with a faint, minute, whitish pupil; fringe pale dirty yellow, interrupted rather broadly at the interspaces with blackish fuscous.

Abdomen above blackish brown, largely sprinkled on the sides and apical half of upper surface with fulvous scales; beneath dirty, grayish, often yellowish white. Male appendages (33:37): upper organ with the centrum only half as long as broad, longitudinally channelled a little on either side of the middle; hook fully as long as the centrum, beyond the basal third as broad as high, straight; clasps apparently formed of two longitudinal pieces, the upper, bearing the recurved hook, being sinuous, of nearly equal breadth throughout, and less than half as broad as the clasp proper; the recurved hook is small, bent backward at a right angle and a little inward, and bears four

or five diverging spines, which give it a palmate appearance; the clasp proper is from two to three times as long as broad, has a rather broadly rounded, spinigerous hinder border, and a considerable laminate dentation near the tip within, and also near the middle of the lower border within; the upper process is small, of equal breadth, broadly rounded at the tip, about twice as long as broad, a little incurved but mainly parallel with the clasp.

Measurements in millimetres. Length of tongue, 9 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	25.75	26.5	29.5	28.	31.5	33.
antennae.....	12.	12.75	14.5	13.	14.	14.5
hind tibiae and tarsi..	8.	9.	9.5	9.	9.75	10.
fore tibiae and tarsi..	3.	3.1	3.75	3.5	3.8	4.

Described from 4♂, 5♀.

Malformation. In a female specimen I find on the lower wing of both sides, a curious though unequal development of the upper subcostal nervule; on the right side, at about two-fifths the distance from its origin, the vein forks, and then again unites, forming a slight loop less than 1.5 mm. long; on the left wing, at a little before the middle, it forks in a similar manner, and in such a way that one branch seems no more important than the other, that is, without denuding, one cannot tell whether it sends off a superior or inferior branch; the upper branch, after diverging scarcely more than .5 mm. from the lower, continues parallel to it a short distance and then disappears; its total length is 2 mm; the lower, after being by this deflected a little from the course of the nervule, returns to it again as soon as the upper has disappeared.

Egg (64: 23) equally high and broad, narrowing with considerable regularity to the summit, which is about half as broad as the base; vertical ridges very numerous, perhaps about forty, at extreme base, where they are scarcely more than .05 mm. apart, many either amalgamating, generally a little below the middle, or terminating independently, generally a little above the middle, so that at summit there are only eight or nine ridges, and in the upper portion of the egg the interspaces have a width of about .1 mm.; the cross lines are from .04-.06 mm. apart, and the surface is uniformly and minutely punctate and glistening; the summit depression is saucer-shaped, rather shallow, about .15 mm. in width, and the micropyle rosette (67:8) is about .09 in diameter, consisting of a central circular cell, .01 mm. in diameter, and around it two irregular ranges of about twenty-five pentagonal cells, the inner ones longer than broad, the others about equal, the whole rosette abruptly terminating against the surface beyond, the entire depression very minutely punctulate.

Caterpillar. *First stage.* Head dusky; body pale greenish brown, mottled with dull white, encircling the black base of the hairs; hairs black. Length, 4.5 mm.; breadth, .64 mm.

Second stage. Head blackish. Body dull ferruginous, dusky at the incisures, a stigmal series of roundish, dull white spots at either extremity of each segment, those of adjoining segments separated only by the incisures; a similar dorsal series; spines and papillae on which they rest, black; legs and prolegs black; spines of equal length throughout. Length, 7.9 mm; breadth, 1 mm.; length anterior spines, .25 mm.

Third stage. Head black. Body orange ferruginous, with an interrupted, dorsal, dull whitish stripe and a suprastigmal, moderately narrow, white belt, broken narrowly once or twice at the anterior extremity of each segment, and tapering just beyond the middle of each segment until lost near the middle of the posterior half; extreme base of legs and prolegs white, beyond black; spines black, the anterior subdorsal pair larger by one-third than the others of the same row. Length 11.8 mm.; breadth, 1.4 mm.; length anterior spines, 1.25 mm.

Fourth stage. Head black. Body dark orange ferruginous; a dorsal and suprastigmal, narrow white stripe broken by several transverse black lines on each segment,

and edged throughout, above and below, with an unequal black line; extreme base of legs and prolegs with a similar black-edged white line, those of the prolegs broken in the middle and each part oblique, the lower edging merging into the black of the members; spines black, the anterior subdorsal pair of the latter longer by about two-thirds than the others of the same row. Length, 23.5 mm; breadth, 3 mm.; length of anterior spines, 3 mm.

The above are described from colored drawings in Mr. W. H. Edwards's possession.

Last stage (75:6, 7). Head (79:1) shining blackish purple, the summit, the triangle and the borders of the same pale reddish orange; a reddish streak through the ocellar field; basal joint of antennae pale, terminal blackish; ocelli black, the upper one reddish, and the others sometimes faintly tinged with the same; labrum pale, mandibles black; labial palpi pale, somewhat annulated with blackish.

Body reddish orange, with broad laterodorsal and suprastigmal black bands; the former encloses white spots, variable in size and arrangement, but generally quadrate and placed along the middle; the latter encloses along its lower portion much more frequent, almost connected, generally transversely quadrate, white spots; there is also a narrower lateroventral, irregular, tortuous band of whitish, and a single longitudinally ovate dorsal spot of white encircled with black on each segment, the abdominal ones much the largest; under surface of body reddish, infuscated; whole surface of the body covered with inconspicuous, short, very delicate, distant, blackish hairs, surmounting minute, speck-like, black warts; spines black or steel-blue; spiracles black. Legs exceedingly dark metallic green, with long, delicate hairs; prolegs reddish infuscated, the apical portion metallic green, the whole covered with long, delicate, blackish hairs; length of body, 30 mm.; of anterior spines, 7 mm.; of other spines, 2.75 mm.; breadth of body, 4.5 mm.; of head, 2.6 mm.

There is considerable variation in the color of this striking caterpillar; the two figures which we publish show this. One drawing by Abbot represents the ground color as dull cinnamonaceous, the longitudinal stripes and blotches nearly white, the spines dark brown.

Chrysalis (84:8, 9). Silvery white marked with black, all the tubercles gilt with their posterior faces sometimes silvery. Summit of the head between the bases of the antennae with a small black spot in front, joining a double black spot on the upper portion of the front, and next the posterior base of the antennae a small spot on either side. Labrum and all the parts below it, together with the tongue, and a large oval spot running up the inner front of each ocellar prominence which encloses a luteous blotch, black; angular border of the tongue-base luteous; summit of the eye with a longitudinal dash of black; the ocellar ribbon luteous, edged broadly over most of either side with black. Antennae yellowish with the division of the joints marked rather broadly with fuscous, at base, where the joints are short, confluent, and deepening into black, and on the club broadly confluent along the median line; extreme anterior base of first joint black. Legs over the anterior half silvery, marked with a few moderately large, black blotches; on the posterior half mostly black. Wings marked broadly with black, never extending upon the nervures; a broad inferior border of black, interrupted in the middle, and two very large, longitudinal blotches, broadly divided by luteous at the nervures, and having some outlying spots in close connection: one shorter, occupying the posterior third of the wing in its length and the middle of the lower half in its breadth; the other, the posterior half and the middle of the superior two-thirds; the superior face of the projecting part of the wing is marked with black and luteous. Thorax marked with a considerable number of small, round, black spots, confluent in front of the tubercles and encircling them with black excepting posteriorly, on the two hinder segments bordering them only on the inner front on the prothorax; on the posterior edge of the abdominal segments is a transverse row of small black spots arranged for the most part in a laterodorsal (at the upper edge of the tubercles), a laterostigmal, suprastigmal, and stigmal series, besides a ventrostigmal one; besides these there is a subdorsal series in the middle of the segments and a laterostigmal both in the middle and on the anterior border of the segments;

there is also a stigmatal anterior series, and the spiracles are black broadly bordered with blackish fuscous; the spots about the spiracles, especially the posterior ones, are often confluent. The tubercles are also edged anteriorly with a straight, transverse dash of black; and all these anterior and central markings become confluent to a greater or less extent on the second to fourth segments, forming a transverse band like a "grecian border." Cremaster dull luteous heavily bordered with black, and the whole ventral portion of the sixth to eighth segments heavily infuscated. Length, 18 mm.; breadth at ocellar prominences, 4.25 mm.; at basal wing prominences, 6 mm.; at superior wing prominences, 6 mm.

Distribution (21:3). This butterfly occurs throughout and also beyond the Carolinian fauna; to the south it is found abundantly in all the Gulf states and is said to be found along the coast of the Gulf of Mexico and Caribbean Sea, through Mexico and as far as Honduras (Reakirt) and Guatemala (Bates). It may be doubted whether it has not here been mistaken for one of the very nearly allied species. I have myself seen it from as far as San Luis, Mexico (Palmer), and Aaron and Lintner both report it from the Mexican border. Westward it reaches the Rocky Mountain region and the mountains of Arizona (Mead, Edwards). It is abundant in Colorado where it has been taken in various places by Mead, Putnam, Packard, Snow and myself. It is found in New Mexico (Snow) and Utah, American Fork Cañon (Scudder); Carpenter reports it from Fort Niobrara, Nebraska, Edwards from the Big Horn Mountains; and north of our border it has been taken at Calgary and the Goose Lake region by Geddes and at Moose Mountain by Miss Pierce. It has been reported from California, but probably by mistake for *E. hegesia*. It is very rare in the northern half of the United States, but has been reported from Pennsylvania, New York (Long Island), New Jersey, Ohio, northern Illinois, Wisconsin, Minnesota and Iowa, and has even been taken in single examples at Cleveland, Ohio (Kirkpatrick), St. Catherines (Beadle), and near London, Ontario (Denton), and at Chateauguay near Montreal (Jack).

In New England it is therefore naturally a very rare insect, but it has been taken repeatedly in eastern Massachusetts; the only instances known to me are the following: Amherst (Parker), Leominster (Shurtleff), Chelsea (P. S. Sprague), Newburyport, several specimens in 1883 (Hayward, Maynard), Malden, four specimens in 1883 (F. H. Sprague), Wollaston (Mason), and Cambridge (Folsom). The northernmost localities in New England are Kittery (R. Thaxter) and near Portland, Maine (Lyman). It has never been taken in New Hampshire as stated accidentally by French; probably New England was intended.

Food and habits of the caterpillar. The caterpillar feeds on various polypetalous plants, having been recorded by Abbot on one of the Berberidaceae (*Podophyllum peltatum* Linn.,—the mandrake or May apple) and on one of the Passifloraceae (*Passiflora incarnata* Linn.,—the

passion flower). Grote and others have found it on the same. It is also recorded from other *Passiflorae*, *P. caerulea* for instance. Mr. Riley has also found it injurious to one of the *Violaceae*,—the garden pansy, *Viola tricolor* Linn., and Mr. Edwards fed specimens readily with violets. In the west Mr. Mead found it on *Sedum*, one of the *Crassulaceae* closely allied to the *Passiflorae*. It is also figured by Abbot on *Desmodium paniculatum*, a leguminous plant, and is said to occur on purslane, one of the *Portulacaceae*. Mr. Riley received it from Norfolk, Virginia, as taken on cabbage, which, however, his informant added, it did not harm, its principal food being the “pop apple” (probably the May-pop, the fruit of *Passiflora incarnata*). Finally Abbot says it feeds on “beggars lice” (*Cynoglossum*?). *Passiflora* and *Sedum* are evidently its favorites. The Cuban species, *E. hegesia* (*P. columbina* Fabr.) which is distinct from ours, has been found by Dr. Gundlach on *Turnera ulmifolia*.

It is probable, as Mr. Edwards suggests, that the larva feeds by night, and by day resorts to stems of bushes and higher plants, for he has found it on black alder several feet from the ground; “it travels,” Mr. Edwards remarks, “with wonderful rapidity and a daily journey of ten feet would be a small affair.” Abbot in several places speaks of the butterfly as common, but the larva as rare (probably because it hides by day).

Life history. The species is apparently triple-brooded; the first butterflies appear very early in the spring, the middle of February in Texas (Belfrage), or the last of March in northern Florida (Chapman). Whether these are hibernating individuals or fresh from wintering chrysalids is not stated, but in either case they probably belong to the same brood as those which appear late in the preceding autumn. In Georgia, caterpillars are full grown early in May and after about eleven days spent in the chrysalis stage, emerge as butterflies (Abbot); apparently these form, properly speaking, the first brood. A second seems to appear about the middle of July in Virginia and Tennessee, when the egg state, according to Edwards, lasts five days (it may be as long as twelve at other seasons), the caterpillar grows to maturity in a fortnight and the chrysalis hangs a week. A third—the only numerous one—appears in the middle of September, becomes abundant by the first of October, and in the extreme south certainly continues, although in diminished numbers, throughout most of November (Chapman). It is possible, perhaps probable, that in the extreme south, other broods are interpolated between these.

As to hibernation, it seems probable: 1, that the butterfly often hibernates; 2, that some of the autumn chrysalids do not disclose their inmates until very early the following spring; and 3, that caterpillars hatched from eggs laid by the October butterflies hibernate either as soon as born or partially grown, reviving in the following spring with the earliest vegetation and developing so rapidly as to transform to the May butterflies.

Mr. Edwards thinks that the caterpillars of the autumn brood probably hibernate when half grown; caterpillars, however, fed on passion flower (their favorite food), all grew rapidly and went through all the changes to butterfly before December; while those fed on violet only passed the second moult by the end of October, and all finally died, the last just as it was about to pupate, on March 22.

In New England the few specimens captured have generally been taken in the first half of August. Mr. Thaxter's Kittery specimen was taken as late as September 1, and Mr. Sprague took a fresh female on September 7 at Malden, besides fresh males on the 17th and 27th of July. It would seem as if these were all members of a single brood. When members of an early May or June brood are found, we may more confidently consider it really indigenous to eastern New England.

The butterflies frequent fields, especially lowlands, and are very partial to flowers,—according to Reakirt, to *Helianthi*; this author adds that it is “of very quick but not high flight”; and Doubleday says that “it is an insect of rapid flight, frequenting open places, especially near rivers, delighting to sit on the dry sand, rising instantly if approached, and very difficult to follow even with the eye.”

Desiderata. The life history of this insect is far too imperfectly known, the above account being largely conjectural or founded on very meagre data. The number of broods, both north and south, might be easily determined by local observers, and the mode or modes in which hibernation is effected especially need attention. Particular attention should be given to any signs of periodic lethargy in the caterpillar. The habits, postures and special characteristics of the flight of the butterfly should be studied, and any parasites of the early stages are quite unknown. It is hardly to be expected that much information will be gained in New England; it must come from more southern observers.

LIST OF ILLUSTRATIONS.—EUPTOIETA CLAUDIA.

<i>General.</i>	<i>Chrysalis.</i>
Pl. 21, fig. 3. Distribution in North America.	Pl. 84, fig. 8, 9. Side views.
<i>Egg.</i>	<i>Imago.</i>
Pl. 64, fig. 23. Colored.	Pl. 14, fig. 4. Female, both surfaces.
67. 8. Micropyle.	33: 37. Male abdominal appendages.
<i>Caterpillar.</i>	39: 4. Neurulation.
Pl. 75, fig. 6. Mature caterpillar.	53: 3. Side view of head and appendages
7. Dorsal view.	enlarged, with details of the structure of
79: 1. Front view of head in stage v.	the legs.

SPEYERIA SCUDDER.

Speyeria Scudd., Syst. rev. Am. butt., 23 Argynnis pars Auct.
(1872).

Type.—*Papilio idalia* Drury.

A butterfly, with gorgeous wings,
To yon tall flag one moment clings,
Then with a sidewise wavering flight,
Rises and flutters out of sight.

KENYON.—*An Incomplete Angler.*

Imago (53:7). Head rather large, profusely covered with moderately long hairs, longest about the base of the antennae. Front pretty full, most so a little below the middle, slightly and broadly depressed above, broader than high, but not nearly so broad as the eye; upper border broadly angular, the apex docked and depressed between the antennae, its sides scarcely curved; lower border rather broadly rounded, scarcely docked. Vertex pretty large and quite tumid, but scarcely rising above the upper level of the eyes, twice as broad as long, the hinder border very broadly rounded and in the middle appressed, the front rapidly sloping, the border extended forward with a broad angulation, the apex docked. Eyes very large, full, naked. Antennae inserted a little in advance of the middle of the summit, in deep pits, with a very broad and pretty deep, transverse channel between them, separated by a space fully equal to the diameter of the apex of the second antennal joint; a little longer than the abdomen, composed of fifty-two joints, the last thirteen of which form a slightly depressed cylindrical club, flattened beneath, suboval in shape, three times as broad as the stalk, two and a half or three times as long as broad, the extremity rather broadly and regularly rounded, four or five joints entering into the diminution of size, the slightly produced apex of the minute, conical, apical joint breaking a little the regularity of the curve, furnished on the upper portion of the inner side with a single slight carina extending a long way upon the stalk. Palpi not very large nor stout, scarcely half so long again as the eye, curving slightly forward, the terminal joint about one-sixth the length of the penultimate, the basal two joints furnished on either side beneath with pretty long, coarse, projecting hairs, and the middle joint above with shorter, scale-like hairs, which grow longer in advance of the eyes, curving upward to partially encircle them, and beyond becoming thinner and projecting upward and forward; only the terminal joint thickly clothed with scales, rather recumbent.

Prothoracic lobes moderately large, not very tumid, a little longer interiorly than exteriorly, in front slightly appressed, the upper surface nearly straight, both ends well rounded, scarcely four times as broad as long, and somewhat higher than long. Patagia very long and slender, slightly tumid, more than three times longer than the extreme breadth, the base moderately broad and nearly square, the posterior lobe tapering rapidly next the base, beyond nearly equal, and bent downward considerably, the tip well rounded, the upper border slightly curved, scarcely sinuate, the under border angulated.

Fore wings (39:2) seven-eighths as long again as broad, the costal border rather strongly convex, the middle half less so, the apical angle well rounded; outer margin nearly straight, rounded off toward the angles; inner border scarcely convex in the ♂, scarcely concave in the ♀, at an angle of about 115° to the outer border. First superior subcostal nervule arising beyond the middle of the outer half of the upper margin of the cell; second at the end of the cell, or a little within the extreme limit of its upper border, which is here pushed outward a little; the third at about two-thirds the distance from the apex of the cell to the outer border; the fourth at but a short distance beyond it, about half way between the apex of the cell and the outer border; second inferior subcostal nervule arising two-fifths way down the cell; the latter slightly more than two-fifths the length of the wing, and three times as long as broad. Last median nervule connected with the vein closing the cell, nearly half as far beyond its base as that is from the base of the first nervule.

Hind wings very strongly and roundly shouldered next the base, beyond which it is slightly (♀) or considerably (♂) convex, the outer angle broadly rounded, outer margin regularly and fully rounded, very slightly full at the upper subcostal nervule (♂) or very fully rounded, prominent, and roundly angulated at the upper median nervule (♀): inner margin broadly and abruptly expanded next the base, beyond straight nearly to the tip of the internal nervure, beyond excised and slightly and roundly emarginate, the angle rounded. Precostal nervure curved strongly outward: first subcostal nervule midway (♂) or two-thirds the distance (♀) from the divarication of the costal and subcostal nervures to the origin of the second subcostal nervule: cell closed.

Androconia ribbon-shaped, equal and slender, about twenty times longer than broad, the basal portion black, the rest pellucid, terminating in a lancet-shaped fringed tip.

Fore legs small, cylindrical, either clothed like the other legs (♀), or furnished also with a very few short hairs on either side not projecting greatly (♂); tibia scarcely more than one-third as long as the hind tibia, the tarsi a little shorter than the tibia; tarsi composed either of a single undivided joint with a bluntly conical apex (♂), or of five joints, visible without denudation, of which the first forms fully three-fifths of the whole tarsus, the second nearly half of the remainder, while the fourth is quite small and the fifth minute, each of the joints excepting the last furnished at tip, beneath, with a pair of short rather stout spurs, the field in which they occur naked; all the joints are also furnished on either side, beneath, with a row of very minute spines easily overlooked (♀). Middle tibiae five-sixths the length of the hind tibiae, furnished on either side beneath with a row of pretty frequent, very long and slender, scarcely tapering, slightly spreading spines, the terminal ones developed to very long and very slender, scarcely tapering spurs; the tibiae are also furnished above and on the inner side with rather numerous short and slender, nearly recumbent spines, irregularly disposed. Tarsi beneath with four very regular rows of frequent, short and rather stout, slightly curving spines, the terminal ones of each joint longer than the rest; above similar spines are profusely distributed on all the joints, scarcely disposed in vague longitudinal rows. Claws long, rather stout, strongly curved at base, beyond nearly straight and equal, the apical third falcate and tapering to a pointed tip; paronychial wanting; pulvillus minute.

Upper organ of male pretty stout, the centrum globose, arched, the hook large, strongly compressed, longer than the centrum, a little curved and directed somewhat downward, the tip minutely hooked; clasps very large, broad and long, more than twice as long as broad, gently curved in either direction, the upper process arising near the middle of the upper border, many times longer than broad, the basal half nearly equal, beyond greatly tapering; main blade expanding roundly at tip and beyond the middle of the upper border, and especially at the upper hinder angle, where a small process is directed upward and a little forward and inward.

Egg. Very short sugar-loaf shaped, scarcely taller than broad; the base a little convex, the sides rounded, swollen a little just above the base, tapering considerably on the upper half, the summit not very small; furnished with a moderate number of heavy, prominent, nearly straight, longitudinal ribs, sharply defined, running from the base to the very summit, nearly as far as the micropyle; in the narrowing upper half of the egg some of the ribs die out, either by sending diagonal offshoots to the neighboring ribs, or by uniting with a neighbor to form a single rib. Surface between the ribs broken up by very distinct, raised cross lines, which traverse also the ribs, nearly as prominent as the ribs throughout, breaking up the whole surface of the egg into pretty deep subquadrangular pits, excepting a central circular space at the bottom of which the micropyle is situated. This is formed of a minute central circle around which radiates a single row of broad lozenge or kite-shaped cells, enclosing between their extremities other larger pentagonal cells.

Caterpillar at birth. So far as the arrangement of hairs is concerned, this genus does not appear to differ from *Argynnis*, but I failed to make the proper comparative studies when specimens of each were in my hands.

Mature caterpillar. According to Mr. Edwards's description, this differs from *Argynnis* in its more fusiform shape, tapering either way from the middle and in the greater length of the spines of the upper row on the third to seventh abdominal segments; the spines of the same row on the first thoracic segment are shorter than the others.

Chrysalis. "Much compressed laterally, the wing-cases very prominent and flaring at the base on ventral side; head nearly square at top, compressed and excavated on the sides with two small ocellar prominences; mesonotum rounded, a little carinated, followed by a deep rounded excavation" (Edwards). Tubercles as in *Argynnis*.

This genus, represented by a single species, belongs to the eastern United States; its exact boundary will be discussed with the species, but it is apparently more abundant in southern New England and on the northwestern prairies than elsewhere.

The butterflies are the finest of *Argynnidi*; they are nearly as large as, and even more superb than, their allies of the genera *Damora* and *Semnopsyche*, and as there the two sexes differ in coloration; the fore wings are orange red, heavily bordered with black and crossed by black markings; four bars cross the cell; the middle of the wing is traversed by a strongly sinuous, angulated series of bars, and the middle of the outer half has a row of small, round spots; besides these, the outer border contains a series of interspacial spots, orange in the male, whitish in the female. There are other apical white spots in the female which are wanting in the male; but beneath, the markings of both sexes resemble the upper surface of the female, excepting that the white is transformed to silvery. The hind wings are blue-black above, with a mesial series of small, whitish spots and a submarginal row of similar red (male) or white (female) spots; beneath the ground is brownish and the spots large and silvery, forming submarginal, extra-mesial, intra-mesial and basal series; there is besides an independent spot at the tip of the cell.

The sole species is single-brooded and flies in the latter half of summer; the caterpillars do not hatch before September, and hibernate before their first moult. Apparently the same phenomenon of continuous and varied development, possibly due to irregular lethargy of the larva, is found here, as occurs in *Argynnis*, where it will be more fully discussed. The flight of the butterflies differs somewhat from that of the species of *Argynnis*, but in general resembles it.

The egg is broader based and more tapering than in *Argynnis* but otherwise closely resembles that genus. The young caterpillar scarcely differs from the same, but the mature caterpillar differs, to judge from descriptions, in its proportionally greater size in the middle, from which it tapers toward either end, in its somewhat curving spines, and the greater size of most of those of the supralateral rows on the posterior half of the body; the body is black, banded and striped with yellow, the spines more or less variegated. The chrysalis is said to be of the same shape as in *Argynnis* and of a similar brown color.

EXCURSUS XVI. — ANTIGENY; OR SEXUAL DIVERSITY IN BUTTERFLIES.

Papillon, qui viens de paraître
 Lorsque le soleil va pâlir,
 Je plains le sort qui te fit naître
 Pour briller une heure et mourir.
 En vain tes ailes sont parées
 Du reflet de mille couleurs,
 Elles n'orneront pas les fleurs,
 Depuis longtemps décolorées.
 Jamais tu ne boiras les pleurs
 Que l'aurore venait répandre
 Dans leur calices pleins de miel,
 Et jamais tu n'iras suspendre
 A leur feuillage d'un vert tendre
 Ta robe où se peint l'arc-en-ciel.

ANON.

If male and female butterflies of the same species always resembled each other more than either resembled the same sex of an allied species, the work of the systematist would be easy, and we may perhaps add,—stupid. No such simplicity, no such stupidity is in store for him. Nature is constantly perplexing him, piquing his curiosity, testing the sharpness of his wit, and leading him on from one comparison or one conclusion to another, till he finds himself confronted with questions of deepest interest and wide purport. It matters little what branch of zoology a student may follow; modern science, with its new questions born of evolution, will not leave the mind to stagnate.

By secondary sexual diversity, or antigeny, as it may be more briefly termed, is meant all such accessory peculiarities of one sex or the other as are not directly connected with generation. They are multiform and multitudinous. The lines of erect hairs on the upper surface of the wings of some Satyrinae and Arynnydi, the gland-like spot at the base of the wings or the powdery band at the margin in some Rhodoceridi, the little oval disk near the middle of the front edge of the upper surface of the fore wings of most Theclidi, the pocket beside the first median nervule of the hind wings of Anosia, the *umschlag* or fold of the front edge of the fore wings in many Hesperidi, and the velvety dash in the middle of the fore wings of nearly all the Pamphilidi, always confined to the males,—these are all accessory sexual peculiarities found on the wings alone, and are quite on a par with the characteristic plumage of the males in many birds. Or, if one seek something still closer, he may find it in the bristling front of the head of the Theclidi.

So when we come to color, and, to a certain very limited extent, to its distribution in definite arrangement upon the surface of the wing, we find the same thing. Here we may pass from the simplest imaginable distinctions to those which are quite extraordinary. In *Vanessa huntera*, for example, a slender, short, transverse stripe near the apex of the upper wings is white in one sex and orange in the other; nothing could be simpler than this,

and the distinction is so slight it might be readily overlooked, yet it is the only difference one can find, and there is nothing analogous to it in the allied species, *V. cardui*. On the other hand, the two sexes of *Erora laeta* have so different an appearance that it is not strange that they were originally described by the same person as two distinct species; and the difference is still more marked in the *Chrysophanidi*, where it may possibly be said to affect also the pattern of coloration. In one species, *Epidemia epixanthe*, the female, besides lacking on its upper surface the brilliant and peculiar lustre of the opposite sex, is also marked by the presence of a row of blackish spots, which is quite wanting in the male. In another, *Chrysophanus thoe*, the male has the upper surface of a deep coppery hue, with a narrow black border; while the female has a deep orange color with a broad black margin and a transverse row of distinct black spots near the middle of the outer half of the wing, which appear in the male only through the diaphanous nature of the wings, the same row occurring in both sexes upon the under surface. This strikes us as the more remarkable, since in the two New England genera which are most closely allied to it, and with one of which it is usually directly associated, no such sexual distinction is found. A somewhat similar example occurs in *Papilio polyxenes*, the male of which presents upon the upper and under surfaces of all the wings, a little distance beyond the middle, a transverse series of yellowish or orange spots, which are equally distinct on the under surface of the female, but partially or sometimes wholly obsolete above. In *Thymelicus brettus* we have even a more conspicuous example. The female is very dark brown, almost black, with two little yellow spots in the middle of the front wings; while the male differs totally, being tawny, with indented brown borders and an oblique black dash in the middle of the front wings: at first glance no one could suppose them identical. In *Semnopsyche diana* the male is a rich dark brown, with a very broad fulvous margin upon all the wings, marked on the front wings by one or two rows of black spots. The female, on the other hand, is a rich purple black, with no trace of fulvous, but with the space where it belongs occupied on the fore wings by three rows of white spots and dashes, and on the hind wings by two belts of blue, broken into spots, one of the belts narrow, the other exceedingly broad.*

It is not a little remarkable that in all these examples, and indeed in very nearly all that have come under my notice, this sexual diversity is displayed only upon the *upper* surface of the wings, and almost invariably upon the fore wings,† a mark of ancestry and of the lower position of

* Here, however, as will be shown in another excursus, the difference is really due to another disturbing element, mimicry.

† De Nicéville states that in *Ergolis*, a genus of oriental *Nymphalidae*, the males have a

large patch of glistening scales on the under surface of the fore wings (Butt. India, ii: 8); and what under the circumstances is curious, these butterflies always settle with expanded wings.

moths, in which the hind wings are covered by the front wings in repose, and are as a rule less ornamented by diverse patterns. We might perhaps anticipate the restriction of the characteristics to the fore wings, since upon the upper surface the complication of colorational design is greater in butterflies on these than on the hind wings; yet this same reasoning makes their restriction to the upper surface the more striking, since the under surface of the hind wings of butterflies is usually more variegated than any other part.

Now in all these cases of colorational antigeny, it is the female and almost never the male, which first departs from the normal type of coloring of the group to which the species belongs. Occasionally the feminine peculiarity has been transmitted to the male, and, by this means, a new type of coloration established in the group; but I recall among our butterflies but one* case where the male alone departs from the general type of coloring peculiar to the group. This is precisely the opposite conclusion to that which Darwin reached. He gives several examples on the authority of Bates, which certainly favor his conclusion, but may, at the same time, be explained from the opposite point of view. He gives other examples from the European blue butterflies, which not only do not support, but even oppose, his general statement.

Take the case of *Semn. diana*, than which we could hardly find a stronger, since the group (*Argynnidi*) to which it belongs is remarkably uniform, exhibiting in all its numerous members the same characteristic play of fulvous and black markings. The male of *S. diana* is indeed very unlike most other fritillaries, but it retains, nevertheless, abundant traces of the same style of ornamentation, and has precisely the same colors; while the female departs widely from the characteristic features of ornamentation in the group, and in addition, loses every trace of fulvous, so that no one at first glance would recognize it as a member of the *Argynnidi*. Or, if it be objected that a case of variation through mimicry should not be used here, take *Eurymus philodice*, and its allies. In some *Eurymi*, indeed, there are only pale females; but in others all, or most of the females, are yellow or orange, like the males; and any one who knows how yellow and orange tints prevail throughout the group of *Rhodoceridi* will acknowledge that the color of the males is normal. So, too, with the blues (*Lycaenidi*), which Darwin himself quotes; in almost all of them, both males and females are of some shade of blue; in comparatively few, the males are blue and the females brown; in exceedingly few, both sexes are brown; and the very fact that they are familiarly known as "blues" is a popular recognition of the prevailing color. In the group of skippers to which *Thymelicus brettus* belongs (*Pamphilidi*), the prevailing colors, at least in

* *Cyaniris pseudargiolus*, in which both sexes are ordinarily blue upon the upper sur- face, but in the south the male is sometimes brown.

the temperate zones, are certainly tawny and black or brown; the latter, marginal. This is the case with the male of *T. brettus*, while the female diverges from the type in becoming wholly brown. In *Jasoniades glaucus*, where we sometimes have a black female, it is more difficult to decide what should be considered the normal color, owing to diversity of view upon the relationship of many of the swallow-tails; but, to judge only from those agreed by all to be most nearly allied to it, there can be no question whatever that the striped character prevails.

It will also be noticed, in this last case and others given, that wherever partial antigeny or dimorphism is confined to one sex, it is nearly always to the female; *Cyaniris* seems to furnish our only exception to this rule. In these instances, on my hypothesis, half of the females depart from the type; on Darwin's, half of the females, and all of the males. But if, on Darwin's theory, sometimes one-half, and sometimes three-quarters of a species has diverged from the type, why does it so rarely happen that only one-fourth of the species diverges?

The instances given by Darwin, which strongly sustain his view, are drawn from specimens of the South American genus *Epicalia*, found in the rich cabinet of Mr. Bates. The facts, as stated by him, are these: There are twelve species of the genus discussed by him;* of these, nine have gaudy males and plain females; one has plain male and plain female; and two have gaudy males and gaudy females. The plain females, he adds, "resemble each other in their general type of coloration, and likewise resemble both sexes in several allied genera, found in various parts of the world." To examine this case fairly would need a large collection of exotic butterflies. If we confine ourselves to *Epicalia*, we evidently cannot say whether the gaudy or the plain coloring be normal; there would be less variation from the standard on the supposition that the gaudy were the normal type, and in this case it is the female which has departed from the type; but the difference is not enough to form an objection. It is only when we look outside of *Epicalia* that judgment seems to lean toward Darwin's side; but, from the unfortunate want of material, I cannot fairly discuss this point.

Take, however, another case, which appears to be equally complicated,—our native coppers (*Chrysophanidi*). We have one species in which both sexes are fiery red marked with black; another where both are fulvous marked with black; others where both sexes are brown; and several where the male is brown, marked with fulvous, and the female fulvous, marked with brown; others where the male is wholly brown, and the female fulvous, spotted with brown; and again others with fiery male, and brown female. We have nearly every possible variation, but the prevalent feature is a dark male, often with more or less metallic reflec-

* Kirby, in his last general catalogue, gives fifteen.

tions, which sometimes increase so as to give the insect a fiery copper hue; and a fulvous, spotted, and margined female. I do not see how we can possibly discover, with any certainty, from within the limits of the group of coppers, what should be considered the normal type. Nor are we much better off in an examination outside the group; there the prevailing tint is either brown or blue; and I am inclined to think that brown, tending strongly to copper, should be considered the normal type; in which case the males are normal, and the species generally antigenic.

Sexual dimorphism is, however, by no means confined to color or pattern; there is also structural, as well as colorational, antigeny; but as we have already prolonged the present discussion to a sufficient length, we will reserve its further consideration to a future page, when we will treat separately of several characteristic differences between the sexes which are of considerable interest.

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SPEYERIA IDALIA.—The regal fritillary.

[*Idalia* butterfly (Harris); regal fritillary (Scudder); regal silver-spotted butterfly (Maynard); regal silver-wing (Maynard); ideal argynne (Emmons).]

- Nymph. phal. idalia* Drury, Ill. nat. hist., i: 25, pl. 13, figs. 1-3 (1770).
Papilio idalia Fabr., Syst. entom., 516 (1775);—Cram., Pap. exot., i: 69-70, tab. 44, figs. D. E. F. G. (1779);—Panz., Drur. abbild., 58-59, pl. 13, figs. 1-3 (1785);—Herbst, Natur-syst. ins. schmett., ix: 166-168, pl. 252, figs. 3-4, pl. 253, figs. 1-2 (1798).
Argynnis idalia God., Encycl. méth., ix: 252, 263, pl. 37, figs. 1, 1 bis (1819);—Boisd.-LeC., Léop. Amér. sept., 147-148, pl. 43, figs. 1-2 (1833);—Luc., Lep. exot., 108, pl. 56, upper fig. (1845);—[D'Urb.], Can. nat. geol., ii: 354-355 (1857);—Harr., Ins. inj. veg., 3d ed., 285, fig. 110 (1862);—Morr., Syn. Lep. N. Amer., 41-42 (1862);—Edw., Can. ent., xi: 217-219 (1879);—French, Rep. ins. Ill., vii: 149-150 (1881); Butt. east. U. S., 150-153 (1886);—Middl., Rep. ins. Ill., vii: 81 (1881);—Coq., ibid., 162 (1881);—Fern., Butt. Me., 38-39, (1884);—Mayn., Butt. N. E. 22-23, pl. 3, figs. 25, 25a, pl. 4, figs. 25b, 25c (1886).
Speyeria idalia Scudd., Syst. rev. Amer. butt., 23 (1872).
Acidalia cybele (pars) Hübn., Verz. schmett., 31 (1816).

Papilio—Abb., Draw. ins. Geo. Brit. Mus., vi: 32, fig. 7 (ca. 1800).
Figured by Müll., Linn. Natursyst., i, v:

620, pl. 19, fig. 6 (1794);—Glover, Ill. N. A. Lep., pl. 35, fig. 8, ined.

Lastly his shinie wings as silver bright,
Painted with thousand colours passing farre
All painters skill, he did about him dight;
Not halfe so manie sundrie colours arre
In Iris bowe; ne heaven doth shine so bright.
Distinguished with manie a twieckling starre;
Nor Junoes bird, in her ey-spotted traine,
So many goodly colours doth containe.

SPENSER.—*Mutopotmos*.

From you have I been absent in the spring,
When proud-pied April dress'd in all his trim
Hath put a spirit of spring in every thing.

SHAKESPEARE.—*Sonnet*.

Imago (4:3, 8; 12:12). Head covered with dark tawny orange scales and hairs, a few dull whitish ones edging the posterior border of the eye and the outer base of the antennae, and separating the dorsal from the lateral region of the head, by an inconspicuous line running directly backward from the summit of the eye. Palpi covered outwardly with dark purplish scales, intermingled with a few tawny and whitish scales and scattered black bristles, fringed beneath with dark gray hairs, tinged, especially beyond the basal joint with orange, fringed above with pale gray hairs and at tip of penultimate joints with orange hairs. Inner under surface of antennae devoid of scales and bright tawny orange, elsewhere gray, with mingled black and pale yellow scales, the former more abundant on the apical half of the stalk and above, excepting at the base of the joints, the latter on the basal half of the stalk, at the base of the joints and on the sides; club black, the tip and three or four apical joints, especially beneath, more or less tinged with orange tawny. Tongue dark luteo-fuscous at base, with a median line of black; papillae (61:31) long oval, four times as long as broad, the apical rim entire, the central filament rather stout, bluntly conical, half as long as the width of the papilla; they are arranged on the apical twelfth of the tongue, at first on the under side, at the inner margin of each maxilla, but in the middle of their course crossing to the outer edge.

Thorax and patagia covered with dark chocolate brown scales and hairs, those on the front tinged partly with tawny orange; femora dark purplish brown; tibiae and tarsi the same externally, the former pale dull yellowish beneath, the latter fusco-luteous; spines black; spurs reddish, darker at tip; claws dark reddish.

Wings above: *fore wings* brilliant orange, sprinkled near the base, especially on the lower half of the wing, with black scales, marked with numerous purplish black bars and spots; costal margin, as far as the subcostal nervure, black, powdered with dull orange next the base; cell crossed by three similar, sinuous, black stripes, the middle one in the middle of the cell, the others at equal distances from it; besides these the outer limit of the cell is bordered interiorly with black and the upper half exteriorly by a band, which, below this point, curves abruptly outward and then inward to the bottom of the cell, enclosing an orange spot; beyond the cell is a moderately broad, greatly tortuous, broken, mesial stripe of black, commencing at the subcostal and crossing, first the subcostal interspaces diagonally outward, in the middle of their basal two-thirds; next, the middle of the subcosto-median interspace, its interior border continuing the exterior border of the previous part of the band; then, the submedian interspaces by separate sinuous bars in the middle of their basal half, and across the middle of the succeeding interspace by a curving bar, opening inward; beyond this mesial stripe, depending from the costal border, is a triangular, diagonal, black patch with a very vague outline, crossing the subcostal interspaces parallel to the neighboring portion of the mesial stripe; beyond this, across the middle of the outer half of the wing, is a series of six round black spots parallel to the outer border,

one in each of the principal interspaces, that in the lower median interspace largest, a little more than a third the width of the interspace and distant from the outer border by the width of two median interspaces. In the female, however, the uppermost of these spots, and to some extent the succeeding one, together with the neighboring triangular costal patch of black, are merged into a general wash of purplish black which fills the apex of the wing as far as a line drawn along the inner edge of the triangular patch to the lowest subcostal nervule, but which is varied with interspaceal dashes of white, having a powdery edge, situated in two rows: an inner, composed of four spots, the upper two small and triangular, the third largest and subquadrate, the fourth vague, the line of their outer edges subparallel to the outer border and terminating below at the inner edge of the lower subcostal round spot; and an outer, of two small, oblong-ovate, longitudinal spots in the lower subcostal interspaces, just outside the round spots; besides these white spots, the interior border of this black apex is separated by white, instead of orange, from the upper portion of the mesial band, in all but the lower subcostal, and the adjoining portion of the next higher interspace. The outer border is either margined with black to the depth of half an interspace, and followed by sagittate spots of black, seated upon the border, one in each interspace, the upper two subcostal spots separated more distinctly from the margin and much larger, enclosing roundish, triangular, orange spots, the uppermost often paler (δ); or, margined much more heavily with black (equivalent to the outer border and the sagittate spots together) and including, at a general distance of half an interspace from the border, nearer below, farther above, a row of eight roundish white spots, longitudinal above, transverse below, one in each interspace, usually increasing in size upward, the lowest double; the inner border begrimed with dusky scales, increasing toward the tip. Sometimes, at the base of the lower median and medio-submedian interspaces, or of only one of them, a tortuous line is present, in broken continuity with that crossing the middle of the cell; fringe black, interrupted abruptly, but not very broadly, in the interspaces with white. *Hind wings* rich purplish black, besprinkled on the basal third and especially in the subcostal and median area with orange scales and long hairs; a submarginal row of seven interspaceal orange (δ) or cream colored (♀) roundish spots, narrowly edged with gray blue, decreasing in size toward the inner border, averaging half the width of an interspace, their outer edges distant from the outer border by more than half the width of an interspace, their borders powdery. Crossing the middle of the wing is an irregular series of seven similar spots, often vague in the male, cream colored in both sexes, narrowly edged with gray blue, situated in the same interspaces, the middle one smallest and usually triangular; the upper four are arranged in a nearly straight line from the middle of the costal border toward the tip of the upper median nervule; the fourth, fifth and sixth form a second line at right angles to the first; and the seventh falls considerably below that line, lying in the middle of the apical half of its interspace; besides these there is sometimes, most frequently in the female, a vague triangular patch of mingled cream colored and gray blue scales, a little way beyond the extremity of the cell; fringe very dark purplish, interrupted broadly and suddenly at the interspaces with cream white.

Beneath: *fore wings* orange, slightly paler than above, the black stripes about the cell and the mesial stripe similar to those of the upper surface, but more circumscribed; the subapical triangular black patch is also repeated, but rather as an oblique bar reaching to the lower subcostal interspace; the costal edge is black but varied with silvery white streaks and spots, arranged in three transverse series; the first two limited by the penultimate subcostal nervule, and composed of nearly laterally continuous streaks; the first is placed between the cell and the mesial stripe, the second between the mesial stripe and the subapical black bar, and the third beyond it; the last is composed of two or three comparatively short streaks, placed side by side, followed by two greatly elongated ovate dashes in the two lower subcostal interspaces, reaching as far as the submarginal markings; excepting in the lower median interspace, the row of round spots crossing the middle of the apical half of the upper

surface of the wings is not repeated beneath, excepting vaguely, but between these and the submarginal markings there is sometimes a yellow line down the middle of the interspaces; the marginal markings consist of a band of purplish black half an interspace's width, enclosing many olivaceous scales (sometimes occupying the greater part of each interspace), followed directly by a series of silvery white triangles, bordered, especially interiorly, with purplish black, each whole one nearly as broad as the interspace; the inner border as far as the submedian nervure, and, on the basal half of the wing, the lower portion of the next interspace, brown gray. In the female, the whole apex of the wing is washed with olivaceous, where it is orange in the male; fringe as above. *Hind wings* dark, rather brilliant olivaceous, the inner border, as far as the submedian nervure, and, in the outer third of the wing, the lowest median nervule, purplish black; basal half of the costal and inner borders broadly bordered with silvery white, the margin itself black: at the junction of the costal and subcostal, the subcostal and median, and the median and submedian nervures, a moderately large, subovate, silvery white spot. Crossing near the middle of the cell, but scarcely reaching either side, is an oblong, transverse, subquadrate, silvery white spot: beyond this are three rows of silvery white spots, all more or less edged with purplish black; the first, consisting of five spots, is the most irregular; the first of them is transversely ovate, situated in the costo-subcostal interspace, either just beyond the first divarication of the subcostal nervure (♀), or just opposite its second divarication (♂), and extends across the whole interspace: the second, very small, is in the upper subcostal interspace, next the second divarication of the subcostal nervure; the third is very large, situated on either side of the vein closing the cell and broken into two spots by a very broad bar of purplish black; the interior of the two is subquadrate, but convex within, and the exterior is triangular: the fourth, obliquely ovate, is in the upper two-thirds of the medio-submedian interspace, just below the first divarication of the median nervure; the fifth, very large and greatly elongate-ovate, is in the submedio-internal interspace, directly opposite the fourth; all these spots are pretty broadly bordered interiorly with black and have a powdery exterior outline. The second row of spots crosses the middle of the outer two-thirds of the wing, subparallel to the outer border, and consists of eight large spots, one in each of the principal interspaces, nearly equal in size, the one beyond the cell smallest, the first six elongate, subtriangular, with more or less rounded sides, the last two roundish: the first four, commencing from above, are placed in a nearly straight line, running from a very little beyond the middle of the costal border to the outer border, at the middle of the upper median interspace; the fourth, fifth and sixth are placed in a straight line at right angles with the previous; the seventh and eighth are on a line parallel to these but farther removed from the base by the width of an interspace; all of these spots are heavily bordered at base and tip, narrowly at the sides, with purplish black. The third row consists of a submarginal series of seven triangular spots, one in each interspace between the costal and submedian nervures, each the width of an interspace, their bases removed from the outer border by half the width of an interspace, edged narrowly exteriorly, very heavily interiorly, with purplish black, the interior edging of these spots often commingling with the exterior edging of the previous row of spots; outer border narrowly edged with purplish black; fringe as on the upper surface.

Abdomen purplish black, the base besprinkled above with a few orange scales and long hairs, enlivened beneath, toward the tip, by a few dull orange scales. Appendages of male (33:43): upper organ with the extreme base of the hook expanding slightly at the sides and angulated; hook compressed so as to be laminate, of nearly equal depth throughout until close to the tip, where, especially by an inferior incision, it tapers rapidly to a hooked, delicate point; clasps with the posterior lobe roundly angulated, the superior strongly arched, the upper posterior angle produced to a slightly incurved lobe directed upward and a little forward, tapering on the basal half, equal beyond, rounded at the tip, about twice as long as its apical width and fringed at the posterior edge with long, backward curved, stiff bristles. The apical half of the

interior of the clasp is furnished with forward directed bristles; upper process curved inward a little more strongly than the blade, four times as long as the width of the basal half, the apical half rapidly tapering to a bluntly rounded apex one-fifth as broad as the base of the process, by the excision of the under edge, which is minutely and reversely denticulated, especially toward the tip.

Measurements in millimetres. Length of tongue 19.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	39.5	41.	42.	44.5	46.5	48.
antennae.....	18.	17.75	18.5	18.5	19.	19.75
hind tibiae and tarsi.....	14.25	15.	15.	14.25	15.5	16.25
fore tibiae and tarsi.....	4.25	5.	5.	5.	5.75	6.

Described from 3 ♂ 6 ♀.

Malformation. One specimen examined has two of the joints of the club completely amalgamated on the under side, but not elsewhere, the two combined joints being, at their narrowest, no longer than a normal joint, and, at their broadest, are each equal to a normal joint.

Aberrations: S. I. ASHTAROTH (*Argynnis asturte* Fish., Proc. acad. nat. sc. Philad., 1858, 179-80, pl. 2; *A. ashtaroth* Id., ibid., 1859, 352). Three specimens of a most remarkable suffused variety of this species have been recorded. Two of them were taken in New Jersey, and described and figured by Fisher; a third, taken at Cohasset, Mass., is figured and briefly described by Maynard (Butt. N. E., 22, pl. 4, fig. 25 b. 25 c.); a fourth (Mus. Bost. Soc. Nat. Hist., No. 1226) was captured on Cape Cod by Mr. W. C. Fish.

In this last specimen nearly the whole upper surface is dark, the orange markings being confined, on the fore wings, to the following: the basal half of the cell interrupted by the innermost black bar, broader than usual, the centre of the band bordering the cell exteriorly; a powdery space just beyond this, in the subcosto-median interspace; a similar powdery space at the base of the lower median interspace, extending to a little beyond the second divarication of the median nervure; the basal three-fifths of the medio-submedian interspace and the interspaces below partly powdered with dusky scales on the outer half; the veins of the median and submedian nervures, excepting on the apical fourth of the wing, similarly powdered; and a few powdery scales scattered about the middle of the outer half of the wing; on the hind wings the orange markings are much as usual, but are restricted within a slightly narrower area; as to the whitish markings, the spots at the divarication of the subcostal nervure are present as usual, and form part of an arcuate series, the lower portion of which seems to take the place of the normal submarginal row (which is entirely wanting) in the interspaces, at fully an interspace's width from the border; on the hind wings a similar series of indistinct, sometimes obsolete spots, occupies the middle ground between the two normal rows, which are altogether absent; fringe as usual.

Beneath, on the *fore wings*, the vivacious colors are again more limited; all the normal black markings of the cell are present, although so changed above, but the dark markings of the middle of the wing are connected, suffused and spread to a great degree; in the submarginal region, nearly the whole space from the cell to the silvery spots is suffused with black; below that the black is sharply defined toward the base of the wing by the interior border of the inner black spots, and exteriorly has a blurred limitation, parallel to the outer border at the middle of the apical median nervules; the outer bordering is nearly or quite an interspace in width, and is followed by broad, long, silvery dashes, angulated externally, broadly bordered with blackish, the lower ones becoming altered to large, roundish spots, bordered with black, the interior border extending far inwards, very nearly to the median spots. On the *hind wings* the silvery spots are slightly tinged with yellowish, and the olivaceous become changed to a brilliant snuff color; the position and character of the silvery spots are greatly changed; that at the base of the costal border is broadened; each of

the interspaces is filled at the base with a very large silvery space, each occupying the place normally belonging to the spots of the two basal rows, together with the intervening area, the black edging being obliterated; the whole cell is filled with silver, and the spot of the submedio-internal interspace is extended to the base; beyond the middle of the wing, the black basal and apical bordering of the silvery spots is retained, excepting the apical bordering of the marginal row, but the spots themselves are absent, being supplanted by a new set of roundish spots, bordered within by the normal exterior border of the inner row, and without by the interior border of the outer row.

Secondary sexual peculiarities. Besides the striking differences between the sexes in the markings of the upper surface of both wings, fully detailed in the description above, the lower median and submedian veins of the fore wings have a thickened appearance in the middle of their course in the male, due to the presence (44:4) of dark scales of unusual size, which here conceal the androconia (46:11) which lie along the upper surface of the vein, mingled with ordinary scales; these have been described under the genus.

Egg (64:34). Sixteen to eighteen longitudinal ribs, at broadest, .065 mm. apart; surface between them covered with minute circular punctulations, about .004 mm. in diameter, distributed pretty regularly over the surface, their centres about .006 mm. apart; the cross lines are finer compressed ridges, nearly as high as the ribs, .07 mm. apart; where they traverse the ribs they become indistinct; on the summit the ribs and cross lines form a pretty uniform subquadrangular pitting, which obtains as far as the micropyle (67:19) which is .1 mm. in diameter; the central circle of this is .0085 mm. in diameter, and the kite-shaped cells of the first row adjoining it are seven in number, and those of the outer row the same; color when fresh laid, pale green, changing subsequently to shining purplish fuscous. Height, .8 mm.; breadth at base, .75 mm.; at summit, .33 mm.

Caterpillar. First stage (72:10). Head (79:2) piceous, with a few long, pale brown, tapering hairs. Body dark olive luteous, the incisures paler, the papillae darker and the hairs pale brown; the latter are shorter than the width of the body, and delicately and distantly spiculiferous. Length of hairs, .34 mm.; length of body, 2 mm.; breadth of head, 3 mm.

Second stage. Head black. Body cinereous, mottled and striped with brown; a macular stripe follows the laterodorsal rows of spines, and another lateral row is independent; spines black, with short black spiracles. Length, 3.8 mm. (after Edwards).

Third stage. Head black. Body mottled and striped with light and dark cinereous; spines longer than before, black, dull yellow at base. Length, 7.6 mm. (after Edwards).

Fourth stage. Head light brown. Body with more contrasted colors, the dark portions quite black, the light of a dirty white; a white dorsal stripe, "through which runs a black line; at the junction of the several segments a transverse white stripe, on which are short black lines: each segment crossed longitudinally by black stripes, interrupted by the spines, with a wedge-shaped mark between the spines; these are long, shining black, with black bristles, and mostly arise from pale orange tubercles." Length, 18 mm. (Edwards).

Fifth stage. Body with the ground color buff, the markings nearly as before; a broad buff band covers the middle of dorsum, enclosing a macular black line; the spines and bases of the spinules mostly orange. Length, 25 mm. (after Edwards).

Last stage (75:10). Head reddish ferruginous on upper half, black below, somewhat pilose. Body velvet black, banded and striped with ochrey-yellow, changing to dull orange or red, olive brown beneath; a broad dorsal band enclosing a sometimes obsolete black line; a series of short laterodorsal yellow stripes; a darker stigmatal band; at the incisures three narrow, transverse stripes above the stigmatal band; the last segment yellow. Laterodorsal spines silvery white with black tips; the other spines yellowish, those of the lower row orange at base and half way to tip; of the upper row part are orange at base; all the spinules black. Legs black; prolegs

smoky brown; spiracles black, with white annuli. Length, 44.5 mm. (after Edwards).

Chrysalis (84:4). "Brown and yellow over abdomen; the mesonotum pinkish brown; the wing-cases brown and more decidedly tinted pink; each [latero-]dorsal tubercle shows a large, dark patch on the anterior side; similar patches on the wing-cases; the tubercles on mesonotum black, and each is joined by a black band to a patch back of and near the base; about the head several irregular dark or black spots; on the wings a brown patch at base, one on middle of disk, and six elongated spots in row within the margin." Length, 28 mm. (Edwards).

Distribution (21:4). This butterfly belongs to the Alleghanian fauna, though its distribution appears to be somewhat irregular. It inhabits lowlands and is much more abundant in the extreme eastern portion of its range than elsewhere, unless it be on the western prairies. It occurs, however, as far south as the elevated parts of Georgia, "taken by Mr. Eliot in his journey to the mountains" (Abbot), whence also it is recorded by Mr. Edwards, who has not been able to discover it in West Virginia. Otherwise, indeed, it has not been recorded on the Atlantic slope south of Pennsylvania. West of the Alleghanies Kirtland states that he has never met with it in northern Ohio, although he has obtained a few specimens from Dayton in that state, and Dury says it is "very rare" at Cincinnati. Worthington reports it from northern and not from southern Illinois, and Kirtland and Hoy have found it abundant in Wisconsin. It has been taken in various parts of Iowa (Allen, Parker, Osborn, Austin, Walton) and it occurs also in Lawrence "common" and Wallace County, Kansas (Snow), Nebraska (Dodge), Arkansas (Edwards) and even Louisiana, according to Strecker.

In New England it is reported abundant in Connecticut at several places and has been taken in Massachusetts about Boston, at Leverett and Montague (F. H. Sprague), about Springfield "quite common" (Dimmock) and in Walpole (Miss Guild); the only places where I have found it tolerably abundant are in Berkshire County, on Cape Cod, and particularly on the island of Nantucket. Generally speaking it is not a common insect and is seldom seen above the annual isotherm of 45°; the most northerly stations from which it is recorded are Waterville (also the easternmost), Norway (Fernald), Hallowell "not very common" (Miss Wadsworth), Brunswick "one may see two or three in the course of an afternoon's walk" (Packard) and Portland, Me. (Lyman); Isles of Shoals "a few specimens" (Thaxter), Milford "common" (Whitney), Wolfboro (Maynard), Suncook "not common" (Thaxter), Dublin (Faxon) and Walpole, N. H. "abundant" (Smith); and Williamstown, Mass. (Scudder). It is very rare at Albany, N. Y. (Lintner) and has not been taken beyond the Kennebec river in Maine.

Haunts. It frequents open breezy meadows or pastures in close proximity to marshy land or ponds. The place where I have found it most abundant is Nantucket, where it occurs sparingly near damp spots next the

'Sconset road, but most abundantly in the Middle Pasture and especially to the west and southwest of Gibbs Pond. In a half acre patch of golden rod just next the sandy beach at the western end I have found them always present in their season, and easier of capture than in the adjoining pasturing ground. They appear fondest of alighting on the flowers of golden rod and *Vernonia*, though (with the possible exception of asters) they are then the most common flower there.

Oviposition and food plants. I took one female in Nantucket on September 11, in the act of laying eggs on a composite plant, one of the *Asteroideae*, *Sericocarpus conyzoides*; but all that have been raised have been fed on violet. Specimens enclosed by me on living violets lay indeed a few eggs on it, but these were as nothing compared to the multitudes,—some hundreds,—laid on the lace which kept them near the violet; these eggs were in all cases laid erect upon the *outside* of the lace, the female thrusting its ovipositor through the mesh (only a millimetre and a half in diameter) curving the tip around and depositing the egg, always on its base. The meshes were felt for as with a snout and many would be tried and pierced before a satisfactory position seemed to be found; the action was repeatedly seen, and the net, sprinkled with eggs on the outside while the parents were within, had a very curious appearance; this leads me to conclude that in nature the eggs are laid upon the under surface of the leaves by the parent seated on the upper surface. The eggs hatch with us in from twenty-nine to thirty-three days; some, however, which were laid late in the season remained unhatched, and in the hope of carrying them through the winter in this state were placed in a cold storage chamber, but the caterpillars never emerged from them.

Duration of early stages, etc. Mr. Edwards, who is the only one that has raised this insect from the egg to maturity, found in West Virginia that the duration of the egg was from twenty-three to twenty-five days (about a week shorter than in the north) and the different stages of the larva from twelve to twenty-three days each, not counting the hibernation, and the chrysalis state seventeen days, making in all, omitting the hibernation, one hundred and forty-four days. The caterpillars usually devour the entire egg shell as far as the base as soon as they emerge and then at once seek shelter and pass into the winter lethargy. Mr. Edwards found that most of his took refuge at the base of the leaf stalks of the violets on which he placed them, but this was probably because a more suitable place was denied them.

Life history. The single brood of this butterfly occasionally appears with us as early as June 25, and then becomes tolerably common by the first of July and abundant after the first week in that month; more commonly however its first appearance is delayed until the first week in July, and its subsequent abundance is correspondingly postponed. Males only can

be found for the first ten days or a fortnight, and the female is generally scarce until the latter part of July. Fresh specimens continue to emerge from the chrysalis until after the middle of August, so that some observers have supposed them to indicate a second brood (See Can. ent., xi: 219). The phenomenon is the same as in the several species of *Argynnis*, but there is no proof as yet of any interruption in the advent of fresh material in the southern part of the range of this species. The butterflies may be found on the wing until the end of the third week in September in the north, and probably later in the south. The eggs are not laid until long after the eclosion of the earliest females, not indeed until the last of August, commonly not until September, and I have had them laid as late as the middle of the month in Cambridge, and Mr. Edwards speaks of securing some the last of September in the south. The larvae hatch, and go at once into winter quarters, the remainder of the history being carried out in the succeeding spring.

Habits of the butterfly. It is found in meadows and open, breezy places, sucking the juices of golden rod, thistle and common red clover. It has a bold and rather majestic flight, sailing more frequently than the other large *Argynnidi*: but it does not move with great rapidity even when frightened, nor is it often seen at any great height, generally flying about four feet from the ground. It is rather wary of approach and will generally fly off in a somewhat labored fashion against the wind, but if pursued will keep just out of reach, or may suddenly dart to one side and then, expanding its wings to the full, be borne along hurriedly by the wind far to the rear of the pursuer. The flight of the female is much less vigorous and sustained than that of the male. The latter generally flies a little faster than one can walk hurriedly, the ample wings are flapped with great vigor but do not seem adapted to swift flight. Mr. H. Skinner, speaking of the females, says "their flight is exceedingly rapid and generally in a straight line for about one hundred feet, and then they do not alight on a flower or bush or flutter about like the male, but suddenly drop like lead in the long grass. It would be almost impossible to tell the exact spot where they alight as they drop so suddenly, but on approach near it they are off like a shot again" (Can. ent., xiv: 20).

The male has a slight musky odor.

When resting in the sun, the wings are fully expanded or droop slightly, the fore wings thrown forward so far as to show the upper extra-mesial spot of the hind wings; the hinder edges of the latter rest upon the ground, and the front of the body is so raised that the plane of the wings is at an angle of fully 30° with the surface of rest. The antennae are straight, raised at a slight angle above the plane of the wings, and divaricate about 125° . When walking, the antennae, still straight, are brought on a line with the upper surface of the body and divaricate only 80° .

When resting for the night on a horizontal surface, the wings are brought back to back, the front concealed as far as possible by the hind pair; the anal angle rests upon the ground, entirely concealing the abdomen, but the trunk is raised above the surface of rest at an angle of 50° , and the antennae lie in a plane perpendicular to the surface of rest, and divaricate at an angle of about 140° . Resting for the night on a vertical surface, the thorax and abdomen have the same bend as before, but the trunk is nearly parallel to the surface of rest, so that the wings project to an unusual degree, the costa of the fore wing falling from the horizontal only about 30° . The antennae hold the same position relative to the body as before.

In some experiments with this butterfly, Dr. Packard found that excision of the antennae affected its action but little.

On putting sweetened water on the ends of the stumps of the antennae, in a minute it partly but not wholly unrolled its maxillae. On moistening the ends of the labial palpi no effect was produced; on moistening the base and ends of the maxillae they at once unrolled and felt about for the sweet object with their tips, and on putting a drop of sweetened water on the window-frame in front of it, it eagerly lapped it with the maxillae, and on losing the place of the drop it felt around until it found it and then again lapped it. (Am. nat., xi: 421.)

Desiderata. The history of the larva in its natural haunts is the most important lack in our knowledge of this species. I have failed to obtain the larva in the field by the use of traps. When that is fairly known it will explain, no doubt, the reason for the long period during which fresh butterflies are leaving the chrysalis. Is there any lethargy in the caterpillars to produce this effect? We also need to know whether the eggs are laid only by long-flown butterflies or whether all, old or new, lay them at the late season. Are the eggs ever laid so late as not to hatch in the autumn? If so, do they hatch at all? And if they do, is the young larva fully developed in the egg before the winter? The natural food plant is still unknown. The distribution of the species needs, no doubt, much revision before it may be considered fairly established.

LIST OF ILLUSTRATIONS.—*SPEYERIA IDALIA*.

<i>General.</i>		<i>Imago.</i>	
Pl. 21, fig. 4.	Distribution in North America.	Pl. 4, fig. 3.	Female, upper surface.
	<i>Egg.</i>		8. Male, both surfaces.
Pl. 64, fig. 34.	Plain.	12:12.	Both surfaces.
67:19.	Micro-pyle.	33:43.	Male abdominal appendages.
	<i>Caterpillar.</i>	39:2.	Neuration.
Pl. 72, fig. 10.	Caterpillar at birth.	44:4.	Median vein of fore wings of male, showing position of scales and androconia
75:10.	Mature caterpillar, mostly dorsal view.	46:11.	Androconium.
79:2.	Front view of head in stage i.	53:7.	Side view of head and appendages enlarged, with details of the structure of the legs.
	<i>Chrysalis.</i>	61:31.	Papilla of tongue.
Pl. 84, fig. 4.	Side view.		

ARGYNNIS FABRICIUS.

Argynnis Fabr. Ill. mag., vi: 283 (1807).

 Argyronome Steph., Cat. Brit. Lep., 13, 258
(1850).

 Type.—*Pap. aglaja* Linn.

Stay thy soft-murmuring waters, gentle Rill;
Hush, whispering Winds; ye rustling Leaves be still;
Rest, silver Butterflies, your quivering wings;
Alight, ye Beetles, from your airy rings;
Ye painted Moths, your gold-eyed plumage furl,
Bow your wide horns, your spiral trunks uncurl;
Glitter, ye Glow-worms, on your mossy beds;
Descend, ye Spiders, on your lengthened threads;
Slide here, ye horned Snails, with varnish'd shells;
Ye Bee-nymphs, listen in your waxen cells!

 DARWIN.—*The Botanic Garden.*

Imago (53: 2). Head pretty large, furnished with abundant, longer and shorter hairs, longest around the antennae. Front pretty full, in the middle below considerably protuberant, above broadly and slightly depressed, in the middle slightly and rather broadly hollowed longitudinally; the middle of the upper border thrust backward considerably between the antennae, the sides of the projection curving around the antennal bases; broader than high, but not so broad as the eyes. Vertex rather large, rather tumid but scarcely elevated above the upper level of the eyes, more than twice as broad as long, the hinder border broadly rounded, scarcely appressed, the front border abruptly descending, projecting angularly in the middle, the sides of the angulation scarcely rounded. Eyes pretty large, full, naked. Antennae inserted slightly in advance of the middle of the summit in pits, the walls of which are higher behind than in front, connected by a rather broad, deep, transverse furrow separated by a space equal to more than the diameter of the summit of the second antennal joint; considerably longer than the abdomen, composed of from forty-one to forty-nine joints, of which from eleven to thirteen form the greatly depressed club, of which the first four and the last five bear the increase and diminution of size, the central joints being about equal; the club is ovate, five or six times as broad as the stalk, a little more than twice as long as broad, the extremity well rounded, sometimes slightly tapering, the last joint with a minutely produced, conical tip; furnished in the middle beneath with a distinct median and a pair of indistinct, submedian carinae, the former extending down the stalk. Palpi pretty long, nearly or quite twice as long as the eyes, not stout, curving slightly forward, the apical joint about one-seventh the length of the penultimate; clothed beneath, excepting the apical joint, with long, equal, curving hairs, all in a vertical plane; above, in the middle of the apical half of the second joint, with a long, vertical tuft of hairs which embrace the eyes and then diminish in length to the apex, changing their direction at the same time forwards.

Prothoracic lobes pretty large, appressed considerably, but somewhat tumid, larger interiorly than exteriorly, well rounded at either end, the summit well rounded in either direction, about five times as broad as long and twice as high as long. Patagia long and slender, two and a quarter times as long as broad, the base rather broad, squarish, the posterior lobe at first continuing in the line of the outer margin and narrowing rapidly, afterward of nearly uniform width and bent considerably downward in continuation of the inner margin, the tip bluntly rounded.

Fore wings (39: 6) more than two-thirds as long again as broad, the costal border pretty strongly and quite regularly bowed, the apical angle well rounded; outer margin, excepting the well rounded angles, straight or scarcely convex; inner margin straight or scarcely sinuous, at about 100° with the outer border. First superior subcostal nervule arising a little beyond the middle of the outer half of the cell; the second half way or somewhat more than half way from that to the apex of the cell, or shortly

before the apex of its upper border; the third at about two-thirds the distance from the apex of the cell to the origin of the fourth; the latter at about midway between the apex of the cell and the outer border; second inferior subcostal nervule arising nearly half way down the cell; the latter considerably less than half the length of the wing, and somewhat less than three times as long as broad. Median nervure connected with the vein closing the cell by its last branch, scarcely more than one-third as far beyond the base of the last nervule, as that is from the base of the first.

Hind wings with the costal border prominently and roundly shouldered next the base, the basal at about right angles with the distal portion, beyond scarcely convex, the apical angle very broadly rounded; outer border faintly crenulated, well and pretty regularly rounded, slightly fullest in the median area, in the ♀ scarcely angulated at the upper median nervule; inner margin rather abruptly and considerably expanded next the base, beyond straight nearly to the internal nervure, then receding a little, and slightly and roundly emarginate between the internal and submedian nervule, the outer angle rounded off. Precostal nervure curved pretty strongly outward. First subcostal nervule arising either at considerably less than one-half (♂ 61: 1), or at more than two-thirds (♀ 61: 2), the distance from the divarication of the costal and subcostal nervures to the base of the second subcostal nervule; cell closed.

Androconia ribbon-shaped, but broadest at the base and tapering slightly on basal half, rarely more than ten or twelve times longer than broad, the basal third or more black, beyond pellucid, terminating in a lancet-shaped fringed tip.

Fore legs, small, cylindrical, furnished on the outer side with a row of pretty long hairs diverging laterally, less frequent in the female than in the other sex; tibiae either two-fifths the length of the hind tibiae (♂) or a little more than that (♀); tarsi a little more than three-quarters the length of the tibiae, consisting either of a single joint tapering at the tip and sometimes armed with an apical spur (♂), or of five joints visible without denudation, of which the first is nearly two-thirds the length of the whole tarsus, while the remainder decrease regularly in size, the fourth being half as large as the second; excepting the terminal joint they are all provided beneath with a pair of stout and short though not inconspicuous spurs, the field between them naked; besides there is on either side beneath, and especially just beyond each spur, a row of long and slender bristle-like spines on each joint, those of the first joint recumbent (♀). Middle tibiae a little shorter than the hind pair, the sides of the outer three-quarters of the under surface furnished with a row of not very frequent, pretty long and slender, somewhat spreading spines, the apical ones of which are developed into very long and slender tapering spurs; besides, the sides and upper surface are covered rather abundantly with similar shorter, not very prominent spines. Tarsi supplied beneath with four rows of short and slender frequent spines, the two inner rows closely approximate and, on the basal joint, their spines alternate; the apical ones of each joint are stouter than the others; above, the tarsi are covered with multitudinous similar spines, indefinitely arranged in vague rows. Claws pretty long and moderately stout, strongly and uniformly curved, tapering and delicately pointed. Parouychia double, the anterior lobe half as long as the claws, regularly tapering to a fine point, and slightly curved in the direction of the claws; the posterior lobe minute, short, triangular, straight. Pulvillus small, transverse, subquadrate, more than twice as broad as long.

Abdominal appendages differing from those of *Speyeria* only in that the clasps are proportionally broader, bear a small lobe near the base of the upper border, and that the upper process is less produced at the tip.

Egg. Very short, sugar-loaf shaped, scarcely taller than broad, largest just above the base, the sides well rounded, tapering upward to a much narrower, feebly rounded summit, the centre of which is depressed; base a little convex, the point of attachment small; furnished with a moderate number of sharply defined, nearly straight and equal, longitudinal ribs, running from the attachment of the base to the micropyle, some of them uniting with their neighbors as in the preceding genus; surface between the ribs broken up by distinct raised cross lines, only not so prominent as the ribs and

placed nearer together than they, and around the micropyle forming a rim. Micropyle rosette made up of minute roundish cells separated by distinct, but coarse, low and rounded ridges.

Caterpillar at birth. Head smooth, broadest in the middle of the upper half, well rounded below, with a few scattered, pretty long hairs arising from minute warts. Body plump and cylindrical, tapering only at the extremity; each segment behind the first thoracic furnished with several series of papillae giving rise to very long, very slender, scarcely tapering, slightly curving, very distantly and excessively minutely spiculiferous hairs, terminating, excepting on some of those of the terminal segment, in a minute, short, cup-shaped club, whose diameter is equal to that of the base of the hair, and is a little narrower than long; the series are disposed as follows: a sub-lateral, each papilla bearing two hairs, the hinder one a little nearer the middle line than the other and longer, a supralateral posteriorly placed, an infralateral centrally placed and an infrastigmatal cluster of four. Legs long and slender, the last joint conical, the claw small, strongly bent, tapering, with a small basal heel; prolegs unusually long and slender and approximated so that there is an unusual space between their outer side and the spiracles. Hooklets five in number, strongly curved, in juxtaposition, arranged in a semicircle, the outer end uppermost.

Mature caterpillar. Head pretty small, well rounded, but anteriorly appressed, subquadrate, broadest in the middle, the hemispheres separated above by a deep sulcation, the sides rather broadly rounded, rather deeper below than above; triangle not very much higher than broad, extending more than half way up the head, covered with sparsely scattered, very minute, blunt warts, giving rise to hairs of variable lengths, one to each, of which those above and outwardly are usually the longest. Antennae with the second joint not half so long as broad, third more than half as broad as second, and more than twice as long as broad, fourth invisible in dried larvae. Ocelli six in number, five in a curve bent at right angles with the angle well rounded, the three middle ones separated by less than their own width, the outer ones by a little greater distance from their neighbors; the sixth is behind the others, at equal distances from the upper and central one of the row, and at a scarcely greater distance from the lowest; they are all of nearly equal size and prominence, but the lowest is a little the most prominent. Labrum small, rather broad, well rounded, pretty deeply and roundly excised in the middle of the front; mandibles very small; maxillary palpi with the second joint about as long as broad, small, rounded; third somewhat slenderer, twice as long as broad, cylindrical.

Body greatly elongated, cylindrical, tapering considerably forward on all the thoracic segments, armed with very long, conspicuous, erect spines, scarcely broadening at the extreme base; the spines are usually very slender, straight, erect, delicately tapering, terminating in a fine pointed needle, often much shorter than those which ornament the sides of the spine, where they are needle-like and moderately long, directed upward at an angle of about 45° with the main spine, simple and seated on small, wart-like spinules; they are irregularly disposed, but are considerably more numerous on the basal than on the apical half of the spine, and are sometimes also scattered along the body in front of the spines, especially of those on the sides; otherwise the body is absolutely naked, excepting for a sparse microscopic pile. The spines vary in length in different species, but most of them are seldom or never less than half as long as the greatest width of the body; they are arranged in longitudinal rows, one to a segment in each row, as follows: a laterodorsal series placed centrally on the thoracic and first to ninth abdominal segments, that of the first thoracic segment sometimes equal to, sometimes of much greater length than the others; a laterostigmatal series placed centrally on the first to eighth and tenth abdominal segments; a suprastigmatal series placed next the suture between the thoracic segments; an infrastigmatal series placed centrally on the first to eighth abdominal segments, and represented also on the second and third thoracic segments by small, spinous warts placed a little lower down; and a ventro-stigmatal series of small, spinous warts, placed centrally on all the segments; spiracles small, obovate, about half as high again as long.

Legs very nearly equal, not very long, slender, tapering, the claws very slender, curving gently; prolegs of moderate length, not very stout, tapering, the hooklets pretty large and prominent.

Chrysalis. Viewed from above, the head is as broad as the sixth abdominal segment, roundly tapering a little to slightly produced lateral angles, which are scarcely advanced beyond the middle of the head; behind the head the body broadens suddenly to the extreme base of the front wing-cases, which bear a short, conical tubercle; the base of the hinder edge of the same is also very full; beyond the third abdominal segment the body tapers pretty regularly to a blunt point. Viewed from the side, the lower portion of the body, from just before the tip of the head nearly to the extremity of the wings is nearly straight; the front of the head is broadly rounded and the prothorax is continued in the same curve, but the mesothorax is independently and pretty strongly arched, more strongly sloped behind than in front, and above flattened slightly; the metathorax and first abdominal segment are constricted so as to make a very deep rounded hollowing, from the summit of the mesothorax to the second abdominal segment; the wing-cases fall off rapidly toward their edges, especially near the ventral line, where the curve is about parallel to that of the front of the mesothorax; the abdomen tapers but slightly before the sixth segment, and then rather rapidly to a blunt cremaster; the last three segments seem to be immovable, and to curve over strongly so as to bring the tip of the cremaster on a line with the lower edge of the anterior half of the body; the ventral surface of the preanal button is broadly flattened to an oval or horse-shoe shaped shield, with slightly raised edges; the cremaster is rather stout, tapering rapidly, constricted at the base above, and strongly compressed, so as to be perpendicularly quadrate at the tip; the fifth to seventh segments of the abdomen have a small mediodorsal tubercle on the anterior edge; besides this there is a laterodorsal series of conical, stont tubercles on all the thoracic and abdominal segments, and inconspicuous suprastigmatal ones on the second to fourth abdominal segments, and similar infrastigmatal ones on some of the segments; spiracles transversely regularly obovate; posterior edges of the movable abdominal segments with a broad, even, but very finely striated border.

Distribution. This genus, very rich in species, is peculiar to that portion of the north temperate zone of both hemispheres which lies between the 35th and 60th degrees of latitude, excluding in America the peninsula of Labrador. It seems to be more abundantly represented in America than in Europe, especially in the western half of the continent, whence numerous forms have been described by Messrs. Edwards, Behr and others and superbly illustrated by the first in his work on American butterflies. From Atlantic North America three species have been described, all of them occurring abundantly in New England; one is found principally in the southern portions, one everywhere except in the White Mountain region, while the third is peculiar to that district and the colder, northern or more elevated parts of New England.

Characteristics. The butterflies for the most part are moderately large, fulvous colored above, and marked transversely with black, thus: four bars traverse the cell of the fore wing, a rather narrow, zigzag, broken band crosses the middle of the wing, a series of roundish spots the middle of its outer half, and there is a submarginal series of sagittate spots upon a dusky border; beneath, the design on the fore wings is a vague repetition of the markings above, while the hind wings are reddish

brown or greenish with a broader or narrower submarginal yellowish band, bordered by a submarginal and an extra-mesial series of large silvery or buff spots; there are also intra-mesial and prebasal series of similar spots, the latter usually smaller than the former.

Life history. These butterflies are all single brooded, first appearing in New England late in June or early in July, continuing to emerge from the chrysalis uninterruptedly throughout July and a part of August, and not laying their eggs until the last of August or the first of September; the eggs thus lie for a long period wholly undeveloped in the ovaries of the female or at least of those which first emerge. So far as I can discover, the period of all European or American species is the same*, with the single exception of *A. calippe*, of our Pacific coast, which according to Mr. Wright flies only in spring for six weeks (Edwards, Butt. N. Am. iii). But in the southern part of the range of our New England species, and probably also in *A. Edwardsii*, to judge by Mr. Mead's observations in Colorado, there is an *interrupted* series of emergences from the chrysalis, giving the appearance of two broods. To quote Mr. Edwards:—

“There are one or two points in the life history of the larger *Argynnides* that are not yet clear. With us [W. Va.], *cybele* ♂ is on the wing from the 25th of May to the 10th of June, as I have noticed for several successive years. Probably *aphrodite* nearly as soon, and [*Semnopsyche*] *diana* first appears about the 20th of June. Shortly after the 1st of June the ♀ of *cybele* is to be seen and both sexes abound in the clover fields. By the end of June *cybele* has become scarce, and the individuals to be seen have lost their freshness and are broken and worn. It is certain that these early appearing females have not matured eggs and laid them, because at no time from June to August will anything but rudimentary eggs be found by dissecting, and the eggs do not become distinguishable to the eye until August. They then mature rapidly, and in a few days attain full size. I am confident that no eggs are laid till August. But about the first of that month and all along to near the end of it there appear in great numbers both fresh males and females, as if just from chrysalis, with no abrasion of the hairs on thorax between the wings, which spot is the first to show wear. I doubt if an *Argynnis* could fly two days without thus giving evidence of it. There are flying at the same time many worn individuals, especially females. These last are the first to deposit their eggs, but shortly after, and up to the time of frosts, the others also are in condition to do the same. I see no [other] explanation of the appearance of these freshly emerged butterflies than that they have formed part of the brood of caterpillars hatched the previous fall, some of which brood yielded the butterflies that came out in May and June, and the remainder continued in the larval or chrysalis state until August, and upon these last the perpetuation of the species largely depends, for nine-tenths of the June flight must have been destroyed long before August. If I am right, the preparatory stages of the August *cybele* must consume eleven months out of the twelve.” (Can. ent., vi: 124-5.)

No such interrupted series of emergences has been detected in the history of our three species in New England; but if, as is probable, this is a first step toward true digoneutism, it might well be looked for in southern New England, and should especially be sought for in *A. cybele*. How this is brought about or what is the cause of the long continued

*Buckler, however, records eggs of *A. paphia* in England, laid as early as July 30.

uninterrupted emergence of fresh material from the chrysalis in the north is unknown and needs careful investigation ; but in view of the phenomena witnessed in the neighboring groups it is altogether probable that it is the outcome of a certain degree of lethargy on the part of the caterpillar, which would only need to be periodic and fixed in the south, casual and irregular in the north, to produce exactly the phenomena which we see. Experiment and observation can alone settle the question.

To return to the common history : The eggs—laid upon all parts of the larval food plant—hatch in about a fortnight, and the caterpillars hibernate before eating more than their egg-shells, and they rarely devour the whole of these. According to C. G. Barrett, the European species “pass the winter as small social larvae under a silken tent on the ground” (Ent. monthl. mag., xix : 6) but nothing of the sort has been observed on this side of the Atlantic, where they have been raised in greater numbers. Prittwitz says that the eggs of *A. paphia* continue through the winter, but it was not so in England with some of this species raised by Mr. Buckler ; it did occur, however, with *A. adippe*, although it is probable, from his account, that the larvae were fully developed in the egg in the autumn, and merely hibernated within instead of without the egg. The caterpillars feed singly, and are commonly found upon *Violaceae* but have also been taken—at least in Europe—on *Rubus*, *Crataegus*, *Ribes* and *Urtica*, besides several *Cruciferae*, such as *Cheiranthus*, *Hesperis*, *Arabis* and *Dentaria* ; as well as on *Onobrychis*, *Plantago* and *Borrago*. They grow very slowly, usually feeding only by night and hiding beneath the leaves or in crevices in the ground by day. The chrysalids may be found on the under surface of logs and rails lying upon the ground, and generally continue between two and three weeks. The butterflies may be found in the open parts of woods, in fields and hilly pasture land, or skirting the mountain base ; they are exceedingly fond of flowers, particularly of clover, thistle, golden rod and milk weed ; their flight is rapid, strong, prolonged, frequently high ; they sometimes sail for short distances with expanded immovable wings, often then descending slightly in broad circles.

Characteristics of the early stages. The eggs are short, sugar-loaf shaped, furnished with distinct, rather coarse and rather frequent longitudinal ribs and finer transverse raised lines.

The body of the young larvae is covered with little conical warts, ranged on either side in five rows, four above and one below the spiracles, each giving rise to a single, very long, delicately spiculiferous, clubbed bristle.

The mature larvae are provided with six rows of long, tapering spines, beset with numerous stiff hairs, equidistant as seen in section and radiating like spokes of a wheel ; sometimes one pair on the first thoracic segment is of a different length from the rest ; they are of a dark and rather dull

color, often with longitudinal darker or paler dorsal and lateral bands. Their movements are exceptionally rapid, like those of the swift-travelling Arctians.

The chrysalids are massive, more or less angulate, constricted across the back, the ocellar tubercles only moderately prominent, the thorax keeled and arched, the wing cases ample and protuberant, the abdominal segments furnished on the back with laterodorsal rows of tubercles; they are generally brown, often furnished with golden or silvery spots, especially on the tubercles.

EXCURSUS XVII.—LETHARGY IN CATERPILLARS.

The caterpillar on the leaf
 Repeats to thee thy mother's grief.
 Kill not the moth nor butterfly,
 For the last judgment draweth nigh.

BLAKE.—*Auguries of Innocence*.

ONE of the most inexplicable phenomena in the life-history of butterflies is the fact that during the only period of activity in the preparatory stages, a period when all the energies seem to be concentrated on eating and growing, there should occasionally intervene a lethargic period when all activities are suspended, the creature partakes of no nourishment, moves at most only by its own length to secure a position more to its liking, as a drowsy sleeper turns in bed, and that this period should last for weeks or even months.

There are lethargic periods in the life of every caterpillar, when it has gorged itself to the full and rests quietly to digest its meal; but these last at most but an hour or two. For those that feed exclusively by day, or by night, as the case may be, there is also that slightly longer diurnal period when they enjoy a period of quiet shared with a great body of their fellow creatures, including ourselves. There is further that much longer period of inactivity which comes to those that must pass the winter in the caterpillar stage, a period we call hibernation, and which is immediately related to low temperature and absence of food.

The period of inactivity termed lethargy is directly connected with this last, although neither of the provocative causes are present. It is a period of greater or less duration, lasting from a few days to a few months, generally as much as two or three weeks, often in the very heat of midsummer, when the food-plant of the caterpillar is superabundant and low temperatures are at farthest remove. In some instances it extends from midsummer to winter and so may be called premature hibernation. In nearly, if not quite, all cases it affects only a portion of any given brood of caterpillars, the remainder of the brood continuing on in the regular

course. Even the portion which is concerned in it may be unequally affected, some arousing from the torpor at the end of a few weeks and proceeding regularly thereafter with their transformations; others continuing torpid to and through the winter. This shows its direct relation to hibernation. The same phenomenon occurs in the chrysalis state, where sometimes early in the season a portion of a brood will disclose the butterfly, while another portion will retain the inmates until the succeeding spring. But its occurrence in the active larval stage is far more unexpected.

This lethargy in caterpillars was first observed by a French naturalist named Vandouer more than sixty years ago, but his statements lay a long while nearly unnoticed. According to this observer (a full account of whose observations is given elsewhere), one of the European species of *Brenthis* upon which he experimented flies in May and again in July and August. The caterpillars from the second summer brood are half grown when winter comes, hibernate in this stage and in time produce the spring brood; the caterpillars of the spring brood, when they have reached the hibernating age, late in June, act in a precisely similar manner, and some of them do not arouse until the succeeding spring, when, with the caterpillars of the summer brood, they produce a new spring brood; but other caterpillars of the spring brood, which became lethargic, awoken from their torpidity after a time, resume eating, undergo their transformations, and emerge as butterflies in July and August.

This same feature occurs in some of our own species of *Brenthis* as I have several times observed. It is also found in some of the *Melitæidi*, and I suspect also in the genus *Argynnis* from the fact that there are in some places two apparent broods of the butterfly, months apart, but only one period of egg-laying. Since in these cases the winter is passed in the larval condition, the caterpillar just from the egg, it would appear probable that lethargy makes its appearance in the spring and early summer among the growing caterpillars, or else, what seems less likely, the period passed in chrysalis is very unequal.

It is possible that to this list should be added those *Theclidi* and *Chrysophanidi* which ostensibly pass the winter in the egg state. If, as is probable, these eggs mature during the hot season in which they are laid, and not in the succeeding, cooler, early spring when the caterpillar escapes, then the only difference between these caterpillars and those of the *Argynnid*i is that one passes the winter within, the other without the egg-shell; and their refusal to escape in the warm weather points to premature hibernation, beginning in a kind of lethargy.

The cause of this strange feature in butterfly life must be attributed, like all other points in their history, to the struggle for the perpetuity of the species. Should disaster befall the advance guard who have not halted by the way, the sluggards can take up the work; the chances of survival are,

not doubled perhaps, but greatly increased. Nature seizes upon some phenomenon in the life of each species and turns it to its advantage; thus in the European *Brenthis*, it seizes on the caterpillar's habit of hibernation when half grown, and forces the spring brood of caterpillars at that point in their growth to premature hibernation, in which some continue throughout the hot weather and until the following spring. Do not all these strange phenomena, invariably looking toward the surer survival of the species, point to something superior to the mere forces of evolution, controlling and directing them? Surely, if hibernation be the pure result of physical causation—and nothing seems simpler than that—where are the physical causes that first produced premature hibernation in midsummer? If it be said that this is subsequently induced through inheritance by the habit of the alternating brood, we may ask: Why does not this occur in *Basilarchia*, which winters in the same stage, and in whose caterpillars of the spring brood no such premature hibernation or sign of lethargy occurs? No, the deeper we look into these phenomena, the surer seem to be the signs that the forces provoking the changes and characteristics observed, are doing their work in no blind fashion, but rather under the impulse of some controlling and thoughtful power.

Table of species of Argynnis, based on the egg.

Rugulose pits in interspaces separated from one another by about half their own width. Egg equally high and broad; vertical ribs more than fifteen in number	aphrodite.
Rugulose pits in interspaces separated by much more than their own width.	
Egg distinctly higher than broad; more than fifteen vertical ribs	cybele.
Egg of similar height and breadth; less than fifteen vertical ribs	atlantis.

Table of species, based on the caterpillar at birth.

Hairs not nearly so long as width of body.	
Their spicules inconspicuous	cybele.
Their spicules fully as long as half the width of hair	aphrodite.
Hairs fully as long as width of body.....	atlantis.

Table of species, based on the mature caterpillar.

Spinules not more than one-third as long as the spines, the latter orange luteous at base.	cybele.
Spinules nearly half as long as spines, the latter pale livid at base	atlantis.
(Aphrodite unknown to me, but said to be slenderer than cybele.)	

Table of species, based on the chrysalis.

Basal segments of abdomen particolored.....	aphrodite.
Basal segments of abdomen similarly colored in front and behind.	
Angle made by dorsal and ventral surfaces of front fourth of body about 60°.....	cybele.
Angle as above, about 50°.....	atlantis.
(For best distinctions between aphrodite and cybele, see under aphrodite.)	

Table of species, based on the imago.

The buff submarginal belt separating the two outer rows of silver spots on under surface of hind wings broad.	
Larger; on upper surface a blackish border only on anterior half of fore wings ...	cybele.
Smaller; upper surface of all the wings with an unbroken or nearly unbroken blackish border, except on lower half of hind wings.....	atlantis.
The buff submarginal belt of hind wings, beneath, narrow	aphrodite.

ARGYNNIS CYBELE.—The great spangled fritillary.

[The great spangled fritillary (Gosse); yellow banded silver wing (Maynard).]

Papilio cybele Fabr., Syst. entom., 516 (1775);—Herbst, Natursyst. ins. schmett., ix: 176-177, pl. 253, figs. 1-2 (1798).

Acidalia cybele (pars) Hübner, Verz. schmett., 31 (1816).

Argynnis cybele God., Encycl. méth., ix: 252, 263-264 (1819);—Boisd.-LeC., Léop. Amér. sept., 151-152, pl. 45, figs. 3-4 (1833);—Doubl., Trans. Linn. soc. Lond., xix, pl. 42, fig. 7 (1845);—Morr., Syn. Lep. N. Amer., 42-43 (1862);—Edw., Butt. N. Amer., i, Arg. ii, figs. 1-4 (1868); ii, Arg. vii (1876); Can. ent., vi: 121-125 (1874); xii: 141-145 (1880);—Saund., Can. ent., iv: 121-123 (1872);—French,

Rep. ins. Ill., vii: 150 (1878); Butt. east U. S., 155-156 (1886);—Middl., Rep. ins. Ill., x: 81 (1881);—Fern., Butt. Me., 40 (1884);—Mayn., Butt. N. E., 23-24, pl. 3, figs. 26, 26a (1886).

Argynnis (Argyronome) cybele Steph., Cat. Brit. Lep. 258 (1850).

Papilio daphnis Cram., Pap. exot., i: 89, pl. 57, figs. E. F. (1779).

Argynnis aphrodite Humphr.-Westw., Brit. butt., 3d ed., 46, pl. 12, figs. 4-5 (1856).

Fig. by Glover, Ill. N. A. Lep., pl. 35, fig. 8*; pl. K, fig. 5?, 11, ined.
(Not *Papilio aphrodite* Fabr.)

Comme un éventail de soie,
Il déploie
Son manteau semé d'argent;
Et sa robe bigarrée
Est dorée
D'un or verdâtre et changeant.
DE NERVAL.—*Les Papillons.*

Imago (4:7). Head covered with fulvous hairs, in front paler; in front of the base of the antennae and behind the lower three-quarters of the eyes, pale yellowish. Palpi with the whole of the basal joint, and the whole exterior lower surface pale buff, with long, stiff, black hairs; beneath similar, but tinged strongly with fulvous; upper exterior surface, especially on the apical half, still more strongly fulvous; above yellowish, with intermingled long black scales, and longer fulvous hairs; extreme tip black or fulvous; interior surface pale yellow, streaked with black hairs. Tongue dull fulvous at base, blackish fuscous beyond, the tip luteo-fuscous. Antennae luteo-fulvous beneath, the basal ten or twelve joints heavily marked with white, dusky brown above, the bases of the joints, especially toward the tip, more or less marked with white; club blackish, the basal joint marked a little with white above, the tip dark reddish, and the terminal four or five joints more or less tinged with the same, especially above. Papillae (61:32) occurring only at the tip of the tongue, apple-seed shaped, appressed (seen edgewise in the figure) two to three times longer than broad, shorter than half the width of the tongue, with room for three in the interspace between every pair, the apical filament not a fourth as long as the width of the papilla, a little oblique.

Thorax covered above with fulvous hairs, tinged strongly with olivaceous, excepting on the prothorax and the outside and front of the patagia. Beneath covered with pale brownish yellow hairs, some of them, and especially the exterior ones (most exposed to view), tinged with fulvous. Fore legs similarly marked, the front of the tibiae brighter; other legs yellowish brown, the under surface of the femora covered with silvery brown scales, dotted with black, and the tibiae and tarsi besprinkled slightly with whitish scales. Spines dark reddish brown, with dusky insertions; spurs yellowish brown at base, reddish brown beyond; claws reddish brown; paronychiae yellowish brown.

Wings, above either orange fulvous (♂), or luteo-fulvous, the hind wings very slightly paler (♀). Inner margin of fore wing scarcely sinuous, being very slightly prominent in the middle of the basal half and beyond it very slightly and broadly emarginate. Second superior subcostal nervule arising either one-half (♀) or fully

two-thirds ($\frac{2}{3}$) the distance from the origin of the first nervule to the apex of the cell; the third at scarcely two-thirds the distance from the apex of the cell to the origin of the fourth nervule; the latter midway between the apex of the cell and the outer border. Veins of the fore wing black: basal half of costal margin and of the cell, and from here to the middle of the outer half of the inner border very heavily begrimed with black scales; in the cell, crossing it on either side of the middle and separated from each other by more than their own width are two irregularly sinuous black bars; and midway between the outer and the tip of the cell a similar one; the outer limit of the cell is marked within by a narrow border of black and without by a sickle-shaped, black bar, enclosing below next the cell a semicircular or subtriangular fulvous spot; beyond is an irregular, mesial, rather narrow, black band, extending from close to the costal border at about three-fifths the distance from the base to the submedian nervure a little before the middle of its outer half; it first stretches in a nearly straight line, its inner border always, its outer border generally, zigzag, to the upper median nervule, which it strikes in the middle; here it turns inward again, crossing the middle of the basal half of the upper median interspace as a greatly curved bar, its upper limb stretching far out to join the upper portion of the stripe; the lower median interspace is crossed in a similar manner in the middle of its basal half (sometimes of the basal two-thirds), while in the medio-submedian interspace it is nearly straight, or if curved or bent it is generally in the opposite direction, crossing it beyond the middle of the interspace directly beneath the bar of the upper median interspace. Beyond the mesial stripe, next the costal border, is a short, transverse stripe parallel to the initial portion of the mesial stripe, at about a third the distance between this and the tip, and crossing all the subcostal interspaces excepting the lower half or the whole of the lowermost; between this and the apex of the cell, the lower two subcostal nervules are heavily edged with black, and the median nervules are generally rather heavily bordered with black in both sexes, in the vicinity of the mesial band. In the middle of the apical half of the wing is a transverse series of six round, black spots, in the two lower subcostal and the succeeding interspaces; the fourth and fifth are largest, about half the width of an interspace, and the sixth usually smallest. The outer margin of the wing is narrowly edged with black, and at a distance of one-third the width of an interspace (or rather more than that above) is a similar black line expanding into small roundish powdery spots on the nervules and connected there with the border; the space between these two lines is almost or quite obscured in the upper half of the wing in the female by blackish; following this inner line is a series of roundish fulvous spots, their outer limit the line mentioned and its nervular swellings, their inner the outer curved border of lunular black spots, the arms of which are seated upon or just fail of touching the nervular swellings of the inner marginal line, and the produced inner border of which reach half way to the row of round black spots; in the subcostal interspaces above the round spots, these lunular markings become rather short, longitudinal dashes; fringe dull yellowish white, rather narrowly and gradually interrupted with blackish at the nervule tips. Outer margin of the *hind wings* not so fully rounded as in *A. aphrodite*, with a broken, bent, mesial stripe of black lunules and bars, rather narrower than that of the fore wings; it starts from about the centre of the costo-subcostal interspace, and has first a general direction toward the middle of the upper median interspace on the outer border, but when it has reached the middle of the subcosto-median interspace, it turns at a little more than a right angle toward the inner margin and terminates at the submedian nervure at about two-thirds the distance from the base of the wing; the upper half of this stripe is usually composed of strongly curved lunules opening outward; the subcosto-median interspace is crossed by a straight bar; while the median interspaces are traversed by lunules, but not so curved, nor generally so large as those of the subcostal interspaces; the base of the wing, within this mesial stripe, is begrimed quite heavily with black scales and obscured by long fulvous hairs, sometimes partially concealing the stripe itself but sometimes not extending quite so far; the apex of the cell is crossed by a broad black bar (sometimes obscured) having a faint,

transverse line of fulvous scales; sometimes also the cell is crossed near the apex by a narrower black bar, connected with the apical bar along the subcostal nervure and enclosing a lighter round spot between itself and the apical bar; the bases of the upper subcostal and of the costo-subcostal interspaces are so heavily begrimed with black scales as far as the mesial stripe as to appear almost wholly blackish. In the middle of the outer half of the wing is a series of round black spots, subparallel to the outer border, the exact homologue of those on the fore wings, but much smaller, and between these and the lunules of the mesial row (exactly limited by both) are usually seen clear longitudinally oval spots, the reverse of the extra-mesial row of silvery spots on the under surface. The outer border is narrowly edged with black and is followed by another line distant from it by a little less than half the width of an interspace and connected with it by the black veins, which are sometimes rather broadly grimy and especially at their union with the inner band; the spaces enclosed between these marginal lines are of a slightly darker tint than the rest of the wing; the inner line is followed by slender well-curved lunules, the arms of which fail of attaining it, enclosing between themselves and the line open roundish spots, which sometimes, especially in the female, are slightly paler than the prevailing color. Fringe as on fore wings.

Beneath. *Fore wings* buff colored, tinged, excepting near the apex, with dull orange; the black markings of the basal half of the upper surface are repeated beneath; the row of round spots in the middle of the apical half of the wing is also repeated, but in the subcostal interspaces the spots are dull cinnamoneous and each preceded by a silvery spot; the subapical patch parallel to the initial portion of the mesial stripe, as well as the subcostal veins between this and the cell, are also cinnamon instead of black; the outer border is margined with the same color, heavily above, scarcely at all below, to the width of half an interspace, excepting at the very apex, where it is mustard colored, a tint which is found also along the whole of the costal border; this is followed by a row of sagittate spots, similar to those of the upper surface, blackish in the median interspaces, changing to cinnamoneous above, enclosing little spots between them and the border, which, below, are of the prevailing tint of the wing, but above are more or less silvery and decrease considerably in size; fringe pale buff, interrupted pretty broadly at the nervule tips with blackish fuscous. Basal half of the *hind wings* as far as the middle or even the outer limit of the extra-mesial row of silvery spots (to be mentioned) cinnamoneous, besprinkled on the basal third, especially next the veins, with pale buff scales, even forming, at the divarication of the subcostal nervure, a not very distinct patch, and edging the costal nervure as a similar streak; iridescent silvery spots occur in considerable numbers: the extreme base of the costal border has an oval patch and a few silvery scales are also scattered along the costal and inner margins for short distances; a small spot is seen both at the junction of the costal and subcostal and of the subcostal and median nervures; a small, longitudinally oval, black-edged spot is found a little removed from the junction of the median and submedian nervures and two black-edged round spots in the cell, the upper the larger, lying next the first divarication of the subcostal nervure, the lower sometimes reduced almost to a dot, next the first divarication of the median nervure; then follows a premesial curving row of five very unequal silvery spots, rounded internally and edged on that side with black; the first spot is rudely semicircular, occurs in the costo-subcostal interspace, above the second divarication of the subcostal nervure and crosses the whole interspace; the second in the upper subcostal interspace is almost (sometimes quite) obsolete,—a minute spot, just below the outer border of the first; the third and largest, subtriangular or roundish, occurs just within the extremity of the cell, crosses the whole of it and throws beyond it a little powdery detachment of silvery scales; the fourth is a diagonally transverse streak, crossing the medio-submedian interspace, a little way beyond the first divarication of the median nervure; and the fifth, smaller still, is a longitudinal streak, beside the fourth and in the succeeding interspace. There is an extra-mesial band of seven spots, entirely edged with black but most distinctly on the inner side, rudely, broadly and

longitudinally oval, excepting the sixth, which is roundish and the seventh, which is irregularly transverse; the middle one is smallest and the seventh, which is double, is scarcely larger; the rest are nearly equal, occupying about three-quarters the width of their interspaces; the inner edges of the first four spots run in nearly a straight line from the middle of the costal border to the middle of the upper median interspace at the outer border; the centres of the fourth, fifth and sixth follow a straight line drawn between two points a little way above the tips of the internal and upper subcostal nervures; the interior border of the seventh is on a line with the exterior of the sixth. The outer margin is bordered much as in the fore wings and is followed by a series of seven large, subtriangular, silvery spots, each as broad as an interspace, and situated in the same interspace as those of the extra-mesial row, bordered with cinnameous; the whole space between this series and the extra-mesial forms a broad buff belt—a characteristic mark of the species, traversed by cinnameous veins and upon which the extra-mesial row of silvery spots infringe; fringe as on the fore wings.

Abdomen above and on the upper portion of the sides black, covered profusely with orange fulvous scales and on the basal half with fulvous hairs; below uniform dull buff. Appendages of male (33:44); upper organ: hook deeper just before the tip than elsewhere, the tip pretty strongly and delicately uncinat, solely by the excision of the under surface of the hook; clasps more than twice as long as broad, nearly equal throughout, upper border with a slight rounded elevation near the base, a larger, rounded, incurved one above the lower base of the upper process, and the upper apical one small, similar to the extremity of the clasp, but directed forward and a little upward, and covered with bristly hairs; upper process equal, excepting at the tip, which is slightly expanded, obliquely docked, or a little excised, the upper hinder angle produced so as to make the whole nearly four times as long as broad, and to reach as far as the hinder border of the clasp, the posterior edge minutely and reversely denticulate.

Measurements in millimetres. Length of tongue, 14 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing	33.5	37.	40.	36.5	39.	44.
antennae	16.5	16.5	17.75	16.75	17.5	19.
hind tibiae and tarsi	12.	12.75	13.5	13.	13.	14.5
fore tibiae and tarsi	4.5	4.5	4.75	5.	5.	5.5

Described from 13 ♂, 27 ♀.

Specimens from the south are much larger and duskier than the New England specimens described above. I have received from Mr. W. H. Edwards a number of West Virginian specimens whose fore wings measure 46 mm. Mr. F. H. Sprague has shown me some very small specimens, captured at Mt. Tom, Mass., which he says are of the size usually taken there.

Aberrations. A. C. BAAL (*A. cybele* *abb. a. baal*, Strecker, Cat. amer. macrolep., 111). Mr. Strecker thus describes a suffused male in his collection: "Upper surface primaries, submarginal lunules confluent with the row of round black spots interior to them. Secondaries, submarginal line wanting, submarginal lunules connected and suffused, forming an irregular jagged line; the row of spots interior to this almost obsolete, other marks suffused. Under surface primaries, all black marks increased and more or less confluent. Secondaries, over one-third of wing (basal part) silver, rest reddish brown, paler towards exterior margin; an irregular, rather broad, submarginal band formed of confluent silver lunules and spots."

Accessory sexual peculiarities. The males differ from the females in the neuration of the front wing, as noted above, and in having on the upper surface of the same wings a narrow series of diagonally disposed grayish brown scales on the middle two-thirds of the submedian and lower median nervules, and on the basal three-fifths of the upper two median nervules. These conceal the androconia (46:12), which closely resemble those of *A. atlantis*, except in being proportionally longer and perhaps apically slenderer, and are considerably slenderer than those of *A. aphrodite*;

they measure about .18 mm. in length. The hind wings have on the lower edge of the basal two-fifths of the costo-subcostal interspace, on the upper surface, a row of nearly decumbent, outward directed, long, equal, delicate, pale brown hairs.

Egg (64:39). Sixteen to eighteen longitudinal ribs, distinct and rather prominent, .18 mm. apart at the broadest; transverse raised lines distinct and not very delicate, .05 mm. apart; surface vermiculate, the rugulose depressions minute, irregularly distributed, occupying far less space than the smooth surface; open space at summit, .14 mm. in diameter; micropyle rosette (67:12) .1 mm. in diameter, broken up into minute, irregular, roundish cells, varying from .017 to .021 mm. in diameter. Color, honey yellow. Height, .9 mm.; breadth at base, .7 mm.; at summit, .24 mm.

Caterpillar. *First stage.* Head (79:4) shining piceous, with a few long, pale hairs. Body pale plumbeo-olivaceous, the warts blackish fuscous and the hairs pale brown: the spicules on the hairs can only be distinctly seen with a half-inch objective, and are distant from each other on the same side of a hair by a space equal to two or three times the width of the hair. Length of body, 2.5 mm.; breadth of body, .46 mm.; length of hairs, .27 mm.; breadth of head, .43 mm.

Second stage. Head shining black-brown, subcordate, the vertices rounded, the front flattened and covered with many long black hairs. Body stoutest in middle, dull green mottled with brown, the latter taking the form of interrupted longitudinal stripes: spines black, the tubercles black, excepting those of the infrastigmatal series, which are dull yellow. Legs black; prolegs greenish brown. Length, 3.3 mm. (after Edwards).

Third stage. Head piceous, at the front of the apex of each hemisphere a little conical black process; minute setigerous processes or tubercles scattered over the front. Body chocolate brown, the basal third of the infrastigmatal spines pale yellow, above yellow; the other spines black, excepting that their bases, especially the outer side, are indistinctly yellow, the setae black. Length, 6 mm. (after Edwards).

Fourth stage. Head piceous, yellow posteriorly. Body dark velvety brown; spines black, the basal third of the infrastigmatal series reddish yellow or honey yellow, the base of the laterostigmatal and laterodorsal series distinctly yellow on the anterior segments, the yellow gradually fading posteriorly in the laterostigmatal series, the hinder spines of the laterodorsal series wholly black; the color of the spines is subject to some variation. Length, 10 mm. (after Edwards).

Fifth stage (79:5). Head as before. Body velvety black; laterodorsal spines bright yellow in front, except on the two thoracic, and sixth to ninth abdominal segments, where they are black; laterostigmatal spines bright yellow in front, duller behind: infrastigmatal spines wholly bright yellow; two gray laterodorsal dots on either side of the last thoracic and first to eighth abdominal segments; the color of the spines still varies somewhat. Length, 15 mm. (after Edwards).

Last stage (75:4). Head (79:6) dull black, the upper half of the hinder portion, behind the upper horns, castaneous: mouth parts black, but basal joints of antennae and palpi pale; edge of labrum testaceous. Body dull black, the more exposed portions somewhat velvety: spines shining blackish castaneous, the base of all the thoracic spines and the basal third of those in the two lower rows dull orange luteous; spiracles concolorous. Legs and prolegs shining black, the last joint of prolegs dark fusco-luteous; the pale mammiform vesicle on pronotum is very large, and shows a transverse slit on inflation. Length, 33 mm.; breadth, 5.5 mm. From a specimen received from Mr. W. H. Edwards.

Chrysalis (84:1-3). Brown, stained and corrugated with black, the whole surface glistening; sometimes glossy dark brown, with a fine, indistinct mottling of reddish brown over the anterior half, including the wing-cases: sometimes dark brown, mottled with drab especially on the wing cases, or with lighter brown, lightest next edge of wing-cases; sometimes wholly dead-leaf brown, a little obscure on the wing-cases. A dark line across the anterior extremity of the head, bordered on either side with yellowish brown. Tubercles black excepting the posterior sides of the laterodorsal series in front of the fifth abdominal segment which are yellow. Spiracles oval,

black. Length, 28 mm.; greatest breadth, 10 mm.; breadth of abdomen, 9 mm. (From the descriptions of Saunders and Edwards and a chrysalis skin received from Mr. Edwards.)

Comparisons. For the points of difference between this species and *A. aphrodite* see the next species.

Distribution (21:5). This species belongs strictly to the Alleghanian fauna, rarely surpassing its limits in the east, but occurring more abundantly in its southern than in its northern half; so, too, it is apparently more common in the east than the west, although it extends as far as Wisconsin (Chamberlin, Hoy), Iowa (Austin, Osborn), Osage Co., Missouri (Stolley) and even to Kansas "common" (Snow), Nebraska and Dacotah (Edwards) and, if rightly determined, Fort Edmonton, northern Alberta (Geddes); Mr. Fletcher informs me that it has also been taken at Miry Creek on the North Saskatchewan and on the Red Deer River near Rocky Mountain House, neither far from Edmonton. The most southerly localities from which it has been reported are Kanawha County "abundant" (Edwards), Elk River, W. Va. "plenty" (Edwards) and Draper's Valley, Va. (H. E. Scudder). It is comparatively rare in the northern quarter of the fauna, but (if the species has always been accurately determined) it has occasionally been taken as far as Quebec (Bowles), Montreal common (Caulfield), Ottawa common (Billings, Fletcher), Victoria County (Mead) and London, Ont. (Saunders), in southern Michigan "not common" (Harrington) and at Sault St. Marie, Lake Superior (Bethune). It has not been recorded from Nova Scotia or New Brunswick, but a single specimen was brought from Cape Breton by Mr. R. Thaxter.

In New England, where it is scarcely larger than *A. aphrodite*, the two have been frequently confounded, but *cybele* is found probably throughout the whole area, excepting the White Mountain region and perhaps a part of the region north of it; in the northern half of New England it is uncommon, but in its extreme south exceedingly abundant. The most northern (and, for the Maine localities, the most eastern) places whence it has been received are Portland (Lyman), Brunswick (Packard), Hallowell "very common" (Miss Wadsworth), Bangor (Davis), Waterville (Hamlin), and Norway, Me. (Smith); Isles of Shoals "not common" (Thaxter), Suncook "common" (Thaxter), Milford "very abundant" (Whitney), Walpole (Smith) and Plymouth, N. H., common (Scudder); Miss Soule found it abundant in Stow, Vermont, and Gosse appears to have taken specimens at Compton, Canada.

Haunts. The butterfly is found in open fields, sucking the juices of flowers; it is very fond of thistle, milk weed (*Asclepias*) and iron weed (*Vernonia*), the latter of which it shares in West Virginia, says Mr. Edwards, "with innumerable *Papilios*, *Vanessae* and *Hesperians*, and occasionally an *aphrodite* and *diana*." Captain Geddes found it "attracted by the blossoms of the numerous vetches which occur" in Alberta.

Oviposition. The eggs are laid upon the leaves and stalks of the food-plant, and not, as stated by H. Skinner, dropped from a distance, upon the herbage. Speaking of a single female observed by him Mr. Skinner says "it hovered about a foot in height over a bed of violets, and at intervals would remain stationary and drop an egg from this distance to the food-plant below" (Proc. acad. nat. sc. Philad., 1883, 36). It is not an altogether uncommon thing for an egg to become attached to the scales at the tip of the abdomen of a butterfly or upon one of the hind legs; and it is possible that in the movement of the wings in flight or poising, such an egg might have been swept or brushed off during Mr. Skinner's observation. The butterfly has been seen to deposit its eggs in the ordinary manner and such a wide departure from the common rule must be disbelieved in until it has been seen repeated. If Mr. Skinner had seen the act more than once he would have said so. A single such incident must be laid to accident and not purpose. Still it would be less surprising in this butterfly than in some others, as the caterpillar leaves its food plant on hatching and does not seek it until spring. The eggs hatch in from twelve to twenty-four days according to Edwards. Mine have hatched in fifteen. In one instance, Mr. Edwards obtained 219 eggs from a single female.

Food plant and habits of caterpillar. The caterpillars feed upon different kinds of violets. Mr. Edwards has fed them on "every species of wild violet accessible from the woods, and during the winter cultivated species, and discovered no preference for one more than another. The wild violets were in flower part of the time and the flowers were eaten by the caterpillars with avidity." On one occasion I thought I saw a female acting as if meaning to oviposit on *Convolvulus arvensis*, but no eggs were found on the plant.

In escaping from the egg the caterpillar sometimes devours nearly the whole shell before forsaking it; usually, however, it destroys only about half of it and sometimes it merely bites a hole in the upper half just large enough to crawl through and leaves it. Like all other species of the genus it is a very secretive caterpillar, lying in concealment most of the time, hurrying to its pasture when hunger impels, feeding voraciously and then returning to its retreat. It was found by Mr. Saunders in spring "in swampy ground, hiding by day in holes made by the feet of cattle, and concealed also by dead leaves which are more or less filled with holes" (Edwards, Butt. N. Amer.). According to Mr. Edwards, who has reared it on several occasions, it is impatient of confinement, tender and raised only by the greatest care. When about to pupate, it seeks the under surface of logs and stones or bark, and making use of this proclivity by scattering, in the vicinity of violet patches by the edge of woods, bits of bark with the rough convex side uppermost, Mr. Saunders succeeded in obtain-

ing many full-grown caterpillars. The period of the ehrysalis is from fourteen to sixteen days according to Saunders, sixteen to twenty according to Edwards, and he gives one instance where it was twenty-four days.

Life-history. The insect is single-brooded in New England, passing the winter in the larval state. The caterpillars become full-grown in June, and the earliest butterflies appear in the latter part of June, sometimes as early as the 16th in the latitude of Boston, usually not much before the 21st, become common by the first of July when the female first emerges, continue to escape from the chrysalis until at least the middle of July, and fly until the middle of September and occasionally later. The butterflies generally pair at the end of July, but the eggs do not begin to assume their proper size until about the middle of August, and are not laid until the last of August or first of September. Miss Soule obtained eggs in Stow, Vt., on August 20, which is the earliest New England date known to me. "It is evident," writes Mr. Edwards, speaking from experience, "that these butterflies take their time for laying their eggs, instead of doing the work all at once as moths do, who die from exhaustion afterwards."

Mr. W. H. Edwards now regards the species as probably digoneutic in the south. There the sexes may be found pairing late in June or early in July, and the early brood of the butterflies, to quote his own words,

Appears in great force here [W. Va.] by 1st June, on the clover blossoms, first the males, and in a few days the females. After the 15th to 20th June they disappear, and in July I scarcely ever see an example. By 15th August fresh males appear again, and soon after fresh females, and I can always obtain eggs between 1st and 20th September. . . . I should not have doubted there being two broods were it not for the fact that the several stages of the larvae which feed in spring are so remarkably prolonged that it seemed unlikely that between 15th June and 18th August the several stages of egg, larva and chrysalis could be passed; and furthermore, that I had repeatedly dissected females . . . in June, and when I could obtain them, in July and first half of August, and never yet found the least appearance of a formed egg. . . . But suddenly, about the middle of August, the eggs begin to take shape, and in a week or ten days are ready to be laid. But the hot weather of July and August, the mercury constantly running between 80° and 95° in this region, and the nights (in which these larvae principally feed) being warm, may accelerate all the preparatory stages." (Can. ent., ix: 35-36.)

This phenomenon has been discussed under the genus.

The eggs hatch, as has been said, in about fifteen days, but the caterpillars from them go immediately into hibernation without eating anything more than their egg shells.

Mr. Edwards was able on one occasion to carry some of the larvae through the winter in a cool room in West Virginia, and their growth during the early spring months differed curiously from that of others which had been kept over winter (five months) in an ice house, as shown by the following table:

Duration.	In cool-room.	After long hibernation.
Duration of second stage of larva...	17	8-12
third stage of larva	11	4-9
fourth stage of larva....	12	5-8
fifth stage of larva.....	14	4-8
sixth stage of larva.....	12	9-12
chrysalis	24	16-20

This was undoubtedly because the caterpillars not enjoying the long and equal hibernation in a cold place were in a less natural and therefore less healthy condition than the others. The earlier stages of those in the cool room were also passed earlier in the season before the hibernators were brought from their place of cold storage.

Flight and posture. The flight of this butterfly is somewhat rapid, rather wandering, with sudden slight changes of course from side to side, usually at an elevation of from three to six feet. When at rest, the antennae diverge at about right angles, the wings are tightly closed, the costal edges of both pairs meeting and the anal angle of the hind wings touching the surface of rest; when walking, their antennae generally diverge from 100° to 110° , although at the base, as far as the tip of the palpi, they divaricate but slightly; with this exception they are straight and raised above the plane of the body at an angle of only 10° .

Parasites. Dr. Riley has reared an *Apanteles*, *A. argynnidis*, from this insect.

Desiderata. The northern limits of the distribution of this butterfly need careful revision, since the species has been so often confounded with *A. aphrodite*. Its occurrence on the Saskatchewan in particular is curious. So, too, its exact range in northern New England, from some parts of which it appears to be absent, needs examination. Is the range dependent upon altitude? The same question arises here as in the other species of *Argynnis*,—what the meaning may be of the first advent of the butterfly so very long before oviposition, and what relation it has to its pseudo-digoneutism in the South. There are several points in this connection which it would be well to establish for several localities by repeated observations:—1. Whether there is any break or fluctuation in the advent of butterflies fresh from the chrysalis; 2. Until how late an epoch these appear; 3. When pairing commences; 4. When oviposition begins; 5. Is this confined to the late appearing females? Other questions which need answering are whether there is any lethargic period for the caterpillars in spring and summer, to account for the long time during which fresh butterflies appear; or whether there is any difference in their arousing in the spring? Is it possible that the female ever deposits by hovering in the air, as Mr. Skinner reports? Parasites of the insect are unknown, with the single exception noted above.

LIST OF ILLUSTRATIONS.—ARGYNNIS CYBELE.

Egg.

Pl. 64, fig. 39. Plain.

67:12. Micropyle.

Caterpillar.

Pl. 75, fig. 4. Mature caterpillar.

79:4-6. Front view of head, stages i, v, vi.

Chrysalis.

Pl. 84, fig. 1. Side view in outline.

2. Dorsal view in outline.

3. Side view.

Imago.

Pl. 4, fig. 7. Female, both surfaces.

33:44. Male abdominal appendages.

43:9. Upper surface wings of male, showing secondary sexual characters.

46:12. Androconium.

61:32. Papilla of tongue.

General.

Pl. 21, fig. 5. Distribution in North America.

ARGYNNIS APHRODITE.—The silver spot fritillary.

[The silver spot (Gosse); Aphrodite butterfly (Harris); silver winged butterfly (Maynard); the Venus fritillary (Morris); Venus's argyune (Emmons).]

Papilio aphrodite Fabr., Mant. ins., ii: 62 (1787).

Argynnis aphrodite God., Encycl. méth., ix: 252, 264 (1819);—Harr., Ins. inj. veg., 3d ed., 285-286, fig. 111 (1862);—Kirb., Faunbor-amer., iv: 290-291 (1837);—Morr., Syn. Lep. N. Amer., 43-44 (1862);—Edw., Butt. N. Am., i, Arg. iii, figs. 1-4 (1868);—Pack., Guide ins., 253, fig. 183 (1868);—French, Rep. ins. Ill., vii: 150 (1878); Butt. east. U. S., 157-158, fig. 40 (1886);—Morr., Hist. Brit. butt., 3d ed., 113, pl. 52 (1880);—Middl., Rep. ins.

Ill., x: 81 (1881);—Fern., Butt. Me., 41 (1884);—Mayn., Butt. N. E., 24, pl. 3, figs. 27, 27a (1886).

Argynnis (Argyronome) aphrodite Steph., Cat. Brit. Lep., 258 (1850).

Argynnis cybele, var. *aphrodite* Herr.-Schaeff., Prodr. syst. Lep., i: 73 (1865).

Papilio daphnis Mart., Psyche, tab. 3, no. 7, tab. 4, no. 9 (1797).

Figured by Glover, Ill. N. A. Lep., pl. K, fig. 8, ined.

[Not *Papilio daphnis* Cramer.]

The grass, with its low insect-tones, appears
As murmuring in its sleep. This butterfly
Seems as if loth to stir, so lazily
It flutters by.

STREET.—*An Autumn Landscape.*

Imago (4:1, 2; 12:11). Head, thorax, and appendages of both, excepting the wings, the same as in the preceding species.

Wings above either orange fulvous, tinged with red, the hind wings paler excepting on the basal half (♂); or luteo-fulvous, tinged faintly with red, especially on the basal half of the hind wings, and suffused with a dull olivaceous greenish hue, particularly on the apical half of the fore wings (♀). Inner margin of the *fore wings* straight, second superior subcostal nervule arising at two-thirds the distance from the origin of the first to the apex of the cell; the third at three-quarters the distance from the apex of the cell to the origin of the fourth; the latter midway between the apex of the cell and the outer border. The veins black; basal half of the costal border, the cell as far as the first transverse band and the basal third of the wing below the cell (in the female rather more than this) rather (♂) or very (♀) heavily begrimed with black scales; the cell is crossed and ornamented at the apex with bars exactly similar to those of the preceding species, although the sickle shaped spot seems usually to have a longer and deeper curve than in that species; beyond is a similar mesial band, extending from close to the costal border at about three-fifths the distance from the base to the submedian nervule at about the same distance from the base; the initial portion of the band is like that of the preceding species and the upper median interspace is crossed by a similar lunule; the lower median nervule is also crossed by a similar lunule in the middle of its basal third (sometimes half) and the medio-submedian interspace possesses a bar usually straight, its interior border sometimes scarcely beyond the middle of the interspace, though usually separated from it by half the width of an interspace; the cross markings and

spots in the apical half of the wing are exactly similar to those of *A. cybele*; between the subapical transverse black stripe and the apex of the cell, the lower two subcostal nervules are distinctly though narrowly edged with black; the median nervules, in the female, are also sometimes bordered with black in the vicinity of the mesial band; fringe black, broadly interrupted with whitish (♀) or buff (♂) in the middle of the interspaces. Outer margin of *hind wings* more fully rounded than in the other New England species. A broken and separated, irregular, bent, mesial stripe of black lunules and bars, slenderer than on the fore wings, starts from about the centre of the costo-subcostal interspace, and has first a general direction toward the middle of the upper median interspace on the outer border; but when it has reached the interspace beyond the cell, it turns at a right angle toward the inner margin and terminates at about the middle of the outer four-fifths of the submedian nervure; the band is irregularly composed of lunules, half lunules, and bars, larger and usually more bent or curved in the female than in the male, and particularly in the subcostal and upper median interspaces. The markings in and at the extremity of the cell are the same as in the preceding species but distinct. The base of the wings is covered with fulvous hairs, and, especially along the median and submedian nervures, is considerably begrimed with dark scales, reaching sometimes, especially in the female, as far as the mesial band but never obscuring it, and very seldom the markings in the cell; in this part of the wing also the red assumes in a slight degree, especially in the female, a fiery hue. On the outer half of the wing the markings are the same as those of *A. cybele* and the fringe conforms to that of the same species, rather than to that of the fore wings.

Beneath: *fore wings*, excepting the upper third of the wing—limited by the lower submedian nervule, either orange buff (♂) or dull reddish orange (♀), the black markings of the basal half of the upper surface repeated; the row of round spots in the middle of the apical half of the wing is also repeated, but in the subcostal interspaces the spots have become cinnamoneous, are more or less merged in other patches of the same color and are preceded by silvery spots, the uppermost quite large; the other spots in the same series are often, especially in the female, preceded by a slight flush or edging of silvery; the subapical patch parallel to the initial portion of the mesial stripe, as well as the subcostal veins between this and the cell, and the whole apex of the wing beyond, excepting the silvery spots already specified, others to be mentioned and also usually some vague, irregular, buff mottlings between them in the two lower subcostal interspaces, cinnamoneous, much darker in the female than in the male; the outer border is margined with the same color to the width of half an interspace, heavily above, scarcely at all below except by a double line; this is followed by a row of sagittate spots, similar to those of the upper surface, black below the lower subcostal nervule, above cinnamoneous or merged in the general tint, enclosing large spots between them and the outer border, which, in the median interspaces are of the prevailing tint, or slightly paler, but above are silvery and do not decrease greatly in size. Between the subapical patch and the extremity of the cell, excepting where the mesial stripe crosses them, the two lower subcostal interspaces are filled with pale buff, most noticeable in the female, and the same color extends to the slender subcostal interspace above, to the apical portion of the summit of the cell between the black bars, and to the base of the subcostal interspaces just above the upper, inner, silvery spot; fringe as above. *Hind wings* either cinnamoneous (♂) or very dark brownish red or cinnamoneous, with a faint vinous reflection (♀), the veins of the same color, faintly besprinkled with buff scales, especially in the female, along the principal veins on the basal third of the wing, and also broadly along the internal nervure to the tip; an oval silvery patch at the extreme base of the costal border, followed by a narrower powdery streak along one-third of the border, and a similar but rather broader edging the whole length of the inner margin; a rather small spot is seen at the junction of the costal and subcostal, and another at that of the subcostal and median nervures; there is a rather large, longitudinally oval, black edged spot a little removed from the junction of the median and submedian nervures,

and two black edged, round spots in the cell, the upper generally much the larger, next the first divarication of the subcostal nervure, the lower, sometimes entirely obsolete, a little within the first divarication of the median nervure; beyond is a pre-mesial curving row of five very unequal silvery spots, rounded internally and edged on the same side with black; the first, in the costo-subcostal interspace, just over the second divarication of the subcostal nervure, crosses the whole interspace and is rudely semicircular; the second, in the upper subcostal interspace, is a small spot, sometimes almost obsolete, just below the outer border of the first; the third is largest, irregular, occupies the whole extremity of the cell, throwing a detachment a short distance beyond it, and is also bordered internally with black; the fourth is a diagonally oval, pretty large patch in the medio-submedian interspace, a little below the first divarication of the median nervure, edged with black along the whole face that looks toward the base of the abdomen; and the fifth is a smaller, longitudinal streak in the succeeding interspace beside the fourth; powdery, longitudinal streaks, which may be said to form a part of this series, occasionally occur at the extreme base of the lower subcostal and median interspaces: the silvery spots of the extra-mesial and submarginal series are precisely as in *A. cybele*, only the submarginal spots are usually narrowly edged externally (sometimes also internally) with black instead of cinnamoneous; and the extra-mesial markings are followed at their exterior tips by a series of small, round, more or less vague, deeply tinted, cinnamoneous spots, occasionally narrowly edged with buff in the female. Between the two outer series of silvery spots there is an irregular narrow buff belt, narrower in the male than in the female, its exterior border pretty distinct and zigzag, formed by the interior edging of the submarginal silvery spots, its interior border very vague, but generally conformable to the outer limits of the cinnamoneous spots at the apices of the extra-mesial silvery spots; the outer bordering of cinnamoneous is sometimes suffused along the middle and especially on the lower half of the wing, with buff; fringe as in *A. cybele*.

Abdomen above and on the upper half of the sides black, covered profusely and especially on the sides toward the apex, where they almost or quite supplant the black, with orange fulvous scales, and on the basal half with fulvous hairs; below uniform buff; hairs of the terminal segment fulvous. Appendages; upper organ of male: hook of equal depth throughout, the tip pretty strongly and delicately uncinat solely by the excision of the under surface of the hook; clasps but little more than twice as long as broad, the apical half curved a little upward, of nearly equal breadth throughout; upper border with a slight but rather abrupt rounded elevation near the base, a similar but not so regularly rounded middle one, while the upper posterior angle is produced to a broad rounded lobe, directed forward and a little upward, larger than any of the others; posterior edge bent in the middle at a right angle, and a little roundly produced at the angle; upper process similar to that of *cybele*, but slightly smaller and not reaching the hinder extremity of the clasp.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 13.25 mm.						
Length of fore wings.....	29.5	33.5	35.5	33.5	39.	39.
antennae	14.	16.	16.25		18.	18.
hind tibiae and tarsi ..	10.35	11.5	12.35	11.5	13.	13.
fore tibiae and tarsi ..	3.75	4.5	4.25	4.75	5.	5.

Secondary sexual peculiarities. The males differ from the females in the character of the squamation of the front wing, in exactly the same way as in *A. cybele*; the androconia (46:13), which are seated on the affected veins, are very similar, but differ from both the other New England species in being proportionally broader, and having the apical feathered portion shorter; the same row of hairs is also found above the subcostal nervule of the hind wings in the male, but in the present species they are brownish fulvous, instead of pale brown, as in *A. cybele*.

Egg (64:35). Sixteen to nineteen longitudinal ribs, prominent and sharply defined, but slender and delicate, about .11 mm. apart, mostly reaching the summit; cross lines quite prominent, but delicate, only less distinct than the ribs, from .06 to .07 mm. apart, not always continuous where they cross the ribs; surface covered with rugulose circular pits, separated from each other by half their own width, the centres about .0075 mm. apart, the intervening raised portions glistening; micropyle rosette .1 mm. in diameter, consisting (67:11) of about seven unequal kite-shaped cells, radiating around a minute central circle, and surrounded at once by much larger and constantly enlarging subquadrate cells. Color toward maturity reddish brown. Height, .8 mm.; breadth at base, .8 mm.; at summit, .23 mm.

Caterpillar. *First stage* (72:5). Head (79:3) shining bronze black, furnished with a few long, pale, curving hairs; mouth parts and whole lower part of head dull luteous. Body dull honey yellow, the anterior half infuscated, the warts pale fuscous, the hairs pale brownish, a little curved. Legs and prolegs pale yellowish, tipped with fuscous. Length of body, 2 mm.; breadth of body, .4 mm.; length of hairs, .23 mm.

Chrysalis (84:5). Livid brown and blackish, the former changing to ruddy brown on the anterior half of the abdominal segments, and to the color of a dead leaf on the posterior half of the same; the wing-cases are livid brown, marked with transverse creases of black, and clouded with the same on the posterior half as far as a line within an interspace's distance of the outer edge; the jointed members black, narrowly annulated with livid. Head black, with a transverse livid band at the anterior extremity below and the parts surrounding the eyes of the same color; above, head and thorax livid brown, inclining to cinnamoneous on the thorax, mottled with black; abdomen with anterior half of segments black, the posterior half livid brown, with a cinnamoneous tinge on first five segments, behind of a dead leaf color; the anterior half of the laterodorsal spines are black, the posterior livid, and the same color runs up on third to eighth abdominal segments between the spines, to the anterior edge of the segment, forming a triangular patch, which, in the segments bearing a spine at this point, covers the posterior half of the same. The last segment is almost wholly black, as is the cremaster, the sides of which are coarsely punctured. Length, 23 mm.; greatest breadth, 8.5 mm.; breadth of head, 5 mm.

Comparison with other species. The most noticeable differences between this species and the preceding are the following: cybele is larger than aphrodite; the bright colors of the *upper surface* are more deeply tinged with red in both sexes of aphrodite than in cybele; the female of the latter lacks the faint olivaceous hue of aphrodite, particularly on the outer half of the hind wings, and the vinous or fiery tint on the basal half of the hind wings; the basal half of both wings is much more heavily and extensively begrimed with dusky scales in cybele than in aphrodite, and the blackish patches at the base of the upper subcostal and costo-subcostal interspaces of the hind wings are wholly wanting in aphrodite; the markings of the upper surface are heavier in cybele; the mesial stripe of the fore wings crosses the lower median interspace, and terminates on the submedian nervure, a very little further from the base of the wing in cybele than in aphrodite; the mesial band of the hind wings is bent a little more sharply in aphrodite, and the band itself is both more broken and more distinct. The color of the *under surface* differs, the comparative brightness of the fore wings being much greater in aphrodite than it is on the upper surface of the same, and the buff colors in the middle of the fore wings, next the costal border, are thus brought into greater relief; the silvery spots on the same wings are larger in aphrodite and the cinnamoneous colors deeper; on the hind wings, the depth and richness of the reds is very marked in the female of aphrodite; the smaller round, silvery spot in the cell is often entirely absent from aphrodite, but present in all specimens of cybele which I have examined; the silvery spots of the outer row are frequently edged with black in aphrodite, but not in cybele; while, however, the silvery spots are nearly identical, the width of the submarginal buff belt is very different in the two species, forming indeed the readiest mark of distinction; in cybele its usual interior limit is the middle of the extra-mesial row of silvery spots, so that the outer halves of

these spots project upon it; in aphrodite its usual limit is the exterior edges of the small cinnamoneous spots found at the apices of the extra-mesial silvery spots, but the cinnamoneous interior bordering of the submarginal row of silvery spots is sometimes so broad as to unite with the reds beyond, and thus to break the buff band by detachments of powdery streaks, and then the contrast to the broad, immaculate belt of cybele becomes more striking; the apical appendage to the silvery spot at the apex of the cell on the hind wings is edged interiorly with black in aphrodite only; the marginal silvery streaks are more decided in aphrodite than in cybele.

The chrysalis of *A. cybele* is more coarsely rugose than that of *A. aphrodite*, while the spines in the present species are less prominent than in *cybele*, with the possible exception of the laterodorsal spines of the prothorax. In markings the chrysalis appears to differ from that of *A. cybele* in having the basal segments of the abdomen particolored.

From *A. alcestitis* Edw., to which the species is, of all others known from North America, the most closely allied, *A. aphrodite* may be distinguished principally by the prevailing tints, and by the total or nearly total absence of a buff submarginal band on the under side of the hind wings. In *A. alcestitis* the color of the upper surface of both wings is alike and exactly that of the hind wings of *A. aphrodite*; in every other point or ornamentation, to the minutest particular, the upper surface is the same in the two species. Beneath, the black and the silvery markings are again the same in the two species; the fore wings are almost uniformly washed with the same tint in *A. alcestitis* that covers the principal portion of the wing of *A. aphrodite*, the buff colors being completely absent, and even the cinnamoneous tints which in *A. alcestitis* supplant the black at the apex are faint and suffused with orange; the tint of the hind wings of *A. alcestitis*, a soft, yellowish cinnamoneous, is uniform over the whole wing, excepting that it is infuscated above each of the silvery spots of the extra-mesial row, and that sometimes a vague tinge of buff is seen in the place occupied in *A. aphrodite* by the buff band.

Distribution (21: 6). In eastern America the range of this butterfly is much the same as that of the preceding species; but whereas *A. cybele* prevails in the south and is scarce in the north, *A. aphrodite*, on the contrary, is rare in the south (i. e., in the southern quarter of the Alleghanian fauna) and abounds in the north, not infrequently encroaching upon the Canadian fauna. Mr. W. H. Edwards states that in the vicinity of Newburgh, New York, *A. cybele* is but little more abundant than *A. aphrodite*; while in the Catskills the latter abounds and *A. cybele* is rare. The most southern localities whence it has been recorded are Kanawha County "occasional" and Elk River, W. Va., "rare" (Edwards), above the base of Big Butte, one of the Iron or Smoky Mountains, Tennessee, three thousand feet above the sea (Bean, fide Uhler) and Black Mountain, North Carolina (Id.). Eastward it is "common" as far as Nova Scotia (Jones); and to the west it occurs in Ohio (Kirtland, Kirkpatrick), southern Michigan "not common" (Harrington, Mich. Univ.), Illinois (Edwards), Wisconsin "abundant" (Hoy), Iowa (Putnam, Osborn), Kansas "one specimen" (Snow), Nebraska and Dakota (Edwards), Edmonton (Geddes) and Woody Mt., Assiniboia (Dawson), Judith Mountains, Montana (Edwards), and even Colorado and Arizona "very rare" (Mead), though the specimens from these localities differ from the type. To the north it has been found at Moose Factory, Hudson Bay

(Weir), Lake of the Woods (Dawson), Sault St. Marie, Lake Superior "abundant" (Bethune), London, Ontario "abundant" (Saunders), Ottawa common (Fletcher), Quebec (Bowles, etc.) and at various points on and about the lower St. Lawrence (Bell). It was once taken in Upton Wood near Leamington, Warwickshire, England, in 1833. "How it came from the 'Far West' is now an undiscoverable mystery" (Morris).

In New England it is one of our commonest butterflies, but is wholly absent from the White Mountain region where it is replaced by *A. atlantis*. There are no means of judging of its abundance in northern Maine, but probably it is less common than *A. atlantis*.

Food plant and habits of larva. Mr. D. W. Beadle of Canada was the first to rear this insect, and according to him it feeds nightly upon all kinds of wild violet, and during the day lies concealed on the ground beneath chips and stones. The eggs are laid in the autumn and hatch in about a fortnight. The young larva devours its egg shell and then moves actively about as if quite equal to finding suitable winter quarters, utterly declining further food, even though placed upon a growing plant, for it hibernates at this age. In the spring its growth is slow, according to Mr. Edwards, and it is active only on sunny days, neither feeding nor moving in cold or cloudy weather. He says of them:—"After remaining motionless for hours, they would suddenly arouse and start off in extreme haste, running all about the enclosure [in which they were kept], and on reaching the leaves would feed ravenously, and then return to their resting place. Not unfrequently they were extended on the stones or the damp earth as if for coolness."

The dim vision probably possessed by caterpillars is well exemplified by an account Mr. Edwards gives of this species. He had the creatures under a guaze bag on violets around which were stuck some sticks.

On one occasion I happened to be at hand when an aphrodite suddenly started down the side of the bag to disappear below, and presently emerge on one of the upright sticks. This it ran over and about, and from a point on the side of it towards the plant made great efforts to reach one of the stems, which was at something more than an inch distant from the stick. Several times the caterpillar stretched itself out till it was nearly twice its natural length, holding to the stick by its anal and last pair of ventral claspers and moving its head and body from side to side to feel for the plant. But the attempts were in vain. Then it remounted the stick, and reached out in a similar manner from the top in directions where were no leaves, till at last it turned right again, and by an effort more violent than usual, seized a stem by its jaws and first pair of legs, and holding by them dropped its body from the stick and climbed to the leaf. There was evidently a sense of direction in the first instance, from the descent of the bag to the reaching the stick, though not of sight, as the stick was fixed at the base of the plant, and the latter was as easily reached as the former. And when on the stick, there was a sense that the leaves were near, without a certainty of the precise locality. (Butt. N. Amer., II.)

Life history. The history of this butterfly in New England is similar to that of the preceding butterfly, since it is single-brooded and hibernates

as a caterpillar just from the egg. It is, however, of the species of *Argynnis*, the last to appear in any given locality. The butterflies make their advent about the first of July, although single specimens are sometimes taken in the latter part of June.* They are seldom abundant before the end of the first week in July and continue plentiful, their numbers replenished by fresh specimens until the middle of the latter half of August, after which they fly in constantly diminishing numbers until the middle of September when they finally vanish. The eggs are not laid until the middle and latter part of August and beginning of September. The earliest I have known are some Miss Soule obtained on August 14 at Stow, Vermont.

Habits, etc. The butterflies are excessively fond of flowers and when feeding can be readily taken with the fingers. In July the sterile hillsides overgrown with thistles seem fairly alive with the butterflies. They frequent also low meadows and usually fly near the ground. Colonel T. W. Higginson writes from Princeton, Massachusetts, in the middle of July:—

Often as I have dreamed of a more abundant world of insects than any ever seen, I never enjoyed it more vividly than in walking along the breezy, upland road, lined with a continuous row of milk weed blossoms and white flowering alder, all ablaze with butterflies. I might have picked off hundreds of aphrodites by hand, so absorbed were they in their pretty pursuit, and all the interspaces between their broader wings seemed filled with little skippers and pretty painted ladies and an occasional comma. The rare *idalia* and *huntera* sometimes visit them also, and a host of dipterous and hymenopterous things. The beautiful mountain breeze played forever over them and it seemed a busy and a blissful world.

After a walk the next day on a road between the two Wachusetts, he adds: "There was nothing of yesterday's procession of milk weed and butterflies, though the latter part of the way the aphrodites and tharos were so thick in the road, I brushed them away."

Speaking of this species Mr. J. M. DeGarmo remarks that it once exhibited remarkable knowledge and as remarkable stupidity.

I found quite a number of them feeding on a cluster of thistles in front of a dis-used barn. Behind the barn was a patch of low sumach bushes, through whose foliage the sunlight filtered in tiny blotches, as from a sieve. The ground underneath was covered with vines of the running blackberry. I came to the barn hurriedly and when near the butterflies tripped in the tangled grass and fell, flinging the net into the thistles. When I arose not a butterfly was to be seen. I went to several adjacent clusters of thistles, but found nothing. I searched all about in vain. Returning in an hour I found them there again, and caught two in a single cast of the net. But after securing them, I discovered that the rest were all gone again. The next day I came determined to spy out the performance. A companion threw the net at the thistles, and lo! the butterflies all flew around the barn, and lighted under the sumac bushes, each on a blackberry leaf. Now the oddest part of this was, that they had made the circumference of the barn to get to the hiding place, when they could have reached it by a short trip directly across the end of the barn; moreover, part of this route was through the shade, which a butterfly usually shuns. Here was another problem. The

* Mr. Saunders reports a specimen taken at London, Ontario, on April 26; but is not this a typographical error? I find no other such statement.

short cut was direct and in the sun. Why did they take the roundabout way? The next day I solved it, for on coming in sight of the place, I saw three or four small boys approaching the thistle patch, straw hats in hand, from the end of the barn, and after their onslaught, not a butterfly was to be seen. The boys were communicative, and I found had made many attempts to catch them. They had invariably come up the same way. . . . The butterflies had availed themselves of their 'organized experience' to dodge the boys.

On following them into their retreat, I found them motionless. . . . But right here their stupidity began, for I caught two of them with my fingers, and could have taken the whole with a little care, had I wanted them. Then I made a grand swing with my net into the sumac bushes, and a more bewildered set of beings it would be difficult to find. They went helter-skelter,—on the barn, on the wall, anywhere and everywhere, without sense or method. On going back again, not a butterfly was to be found. Whether the boys frightened them away, or whether my inroad upon their harbor of refuge disheartened them I never ascertained." (Trans. Vassar Bros. inst., ii: 131-2.)

Postures and flight. The flight of this species and the last do not differ in style. Dr. C. S. Minot has noted that both during the motion of the wings and while sailing, the antennae are kept in constant motion. When at rest on a horizontal surface, according to the same observer, the wings are generally held a little below the horizontal, though when in the sun they are sometimes raised to the perpendicular; while the antennae are raised about 20° from the horizontal and divaricate about 35° . In walking (from observation of half a dozen specimens) he found that the left middle leg and right hind leg moved together and always first; while walking or resting on a perpendicular support the abdomen is raised and concealed within the gutter of the hind wings; but on a horizontal surface it rests, or almost rests, upon the ground.

Enemies. According to Gentry he has identified this butterfly among the mangled remains of insects in the crops of the common night hawk (*Chordeiles virginianus*) and the chimney swift (*Chaetura pelagica*); and he further says that he has also found the caterpillar in the stomachs of the black-throated bunting (*Spiza americana*), the towhee (*Pipilo erythrophthalmus*), and the swamp blackbird (*Agelaius phoeniceus*), but the last assertion, at least, may be taken as doubtful, as the caterpillar was not known at the time of his writing.

Desiderata. Our knowledge of the larva and chrysalis of this species lacks completeness, and the statements concerning the seasons of the insect need the most careful revision. We should especially observe whether there be any accession to the number of butterflies in August, and, if so, whether eggs are laid by the old or fresh females, or by both. The characteristics of the flight of the butterfly as compared with that of its congeners are still undescribed.

LIST OF ILLUSTRATIONS.—*ARGYNNIS APHRODITE*.

<i>General.</i>	<i>Imago.</i>
Pl. 21, fig. 6. Distribution in North America.	Pl. 4, fig. 1. Female, both surfaces.
<i>Egg.</i>	2. Male, both surfaces.
Pl. 64, fig. 35. Colored.	12: 11. Both surfaces.
67: 11. Micropyle.	33: 40. Male abdominal appendages.
<i>Caterpillar.</i>	46: 13. Androconium.
Pl. 72, fig. 5. Caterpillar at birth.	53: 2. Side view of head and appendages enlarged, with details of leg structure.
79: 3. Front view of head in stage i.	(1: 1. Neuration of hind wing, male.
<i>Chrysalis.</i>	2. Neuration of hind wing, female.
Pl. 84, fig. 5. Side view.	

ARGYNNIS ATLANTIS.—The mountain silver-spot.

[The mountain silver-spot (Seudder); mountain silver-spotted butterfly (Maynard).]

Argynnis atlantis Edw., Proc. Acad. nat. sc. Philad., 1862, 54-55 (1862); Butt. N. Amer., i, Arg. v, figs. 1-3 (1868); Can. ent., xx: 1-3 (1888);—Pack., Guide ins., 252 (1869);—Moeschl., Stett. ent. zeit., xxxv: 156-157 (1874);—Middl., Rep. ins. Ill., x: 82 (1881);—Fern., Butt. Me., 42 (1884);—French, Butt.

east. U. S., 160-161, fig. 161 (1886);—Mayn., Butt. N. E., 24-25, pl. 4, figs. 28, 28a (1886).

Argynnis aphrodite Butl., Cat. Fabr. Lep., 108 (1869).

Figured by Glover, Ill. N. A. Lep., pl. 38, fig. 14; pl. L, fig. 7, ined.

[Not *Papilio aphrodite* Fabr.]

Over the fields, in his franke lustinesse,
And all the champaine o're he soared light;
And all the countrey wide he did possesse,
Feeding upon their pleasures bounteouslie,
That none gainsaid, nor none did him envie.

SPENSER.—*Muipotmos*.

Imago (4: 6). Head covered with fulvous hairs barely paler in front, pale buff next the hinder edge of the eyes. The whole of the basal joint of the palpi, the base and the whole lower outer half of the middle joint, white, the upper outer half fulvous, paler next the middle line; apical joint fulvous, inner half of the under surface with long fulvous hairs; inner side as far as the apical joint, white, partially concealed, especially toward the apex, with fulvous hairs; the whole palpus sprinkled with black hairs. Antennae dull orange fulvous beneath, the basal ten or twelve joints marked with white, which diminishes in amount away from the head, blackish brown above and on the club, the terminal four joints bright orange above and below, the fifth tinged with the same on the under surface. Tongue castaneous near the base, the middle line blackish, beyond dark fuscous, the tip dull luteous.

Thorax covered above with fulvous hairs, tinged strongly with olivaceous, excepting on the prothorax. Beneath covered with dirty, pale buff hairs, tinged at the tip with fulvous. Legs as in *A. cybele*; spines yellowish brown; spurs dark yellowish brown; claws reddish brown; paronychial hyaline; pulvillus blackish fuscous.

Wings above either orange fulvous, tinged with red, slightly duller than in *A. aphrodite* (♂); or dull, rather dingy luteo-fulvous, tinged with olivaceous, especially in the begrimed portions (♀), the veins of fore wings black, of hind wings dusky. Inner margin of the fore wings straight. Second superior subcostal nervule arising at about two-thirds the distance from the origin of the first to the apex of the cell; the third at five-sevenths the distance from the apex of the cell to the origin of the fourth; the latter more than half way from the apex of the cell to the outer border. *Fore wings* considerably begrimed, on the cell as far as the middle transverse bar, and on the median interspaces very nearly or quite as far as the mesial stripe, with fuscous scales; cell crossed by bars exactly similar to those of *A. cybele*; the apex is heavily bordered exteriorly and interiorly with black, greatly expanding outwardly in the subcosto-median interspace and en-

closing a generally obscure, small, fulvous spot; beyond is a moderately slender mesial stripe, starting from close to the costal border at about three-fifths the distance from the base and extending to the submedian nervure at an equal distance from the same; the initial portion has a generally straight, oblique direction to the middle of the upper median nervule and is formed of squarish spots in each interspace, each removed a little further from the base of the wing than the preceding; the three succeeding interspaces are crossed by usually straight or but slightly curved bars, the upper median in the middle of its basal half, the lower median at two-thirds the distance from the border, the medio-submedian at about two-fifths the distance from the same; at about two-fifths the distance from the initial portion of the stripe to the apex of the wing, is a transverse stripe, similar to that of *A. cybele* but seldom reaching further than the penultimate subcostal nervure; a row of black spots in the middle of the apical half of the wing is exactly similar to that of *A. cybele*; the two lower subcostal nervules are narrowly bordered with black as far as the round spots and particularly between them and the mesial band; the outer margin is bordered with black to the width of half an interspace, often with a fulvous line running through its middle next the medio-submedian interspace and occasionally a little further up; the inner edge of the bordering is almost always straight, but sometimes hollowed at the interspaces; upon the border are seated (or, in the lower half of the wing, nearly seated) high black lunules or, in the upper two subcostal interspaces, dashes, enclosing between them and the border, rounded triangular, or subcircular, fulvous spots, decreasing but slightly in size above; inner edge of the wing slightly infuscated; fringe black, the outer two-thirds rather narrowly interrupted with yellow or whitish, sometimes externally edged with fulvous. Outer margin of the *hind wings* not so fully rounded as in *A. aphrodite*. Cell, as far as the enclosed black dash, and the lower half of the wing as far as the mesial stripe, and sometimes, to a less extent, all the upper half of the wing, begrimed, like the fore wings, with fuscous scales; the markings in and at the apex of the cell are like those of *A. cybele*; a rather slender, very irregular, broken, mesial stripe, sometimes obscured on the lower interspaces, crosses the wing, starting from the costal nervure next the middle of the border and has a general straight direction toward the outer border at the middle of the upper half of the upper median interspace, but at the spot beyond the cell, it turns at right angles toward the inner border, terminating just beyond the middle of the lower median nervure; a straight bar crosses the costo-subcostal interspace at right angles; an oblique bar directed inward, its outer limit at the middle of the upper subcostal nervule, crosses the next; a slightly oblique, sometimes gently curving bar, subparallel to the first, crosses the lower subcostal interspace about two-fifths the distance from the last divarication of the subcostal nervure; the subcosto-median interspace is crossed at right angles by a bar, sometimes curving inward, scarcely less than half way from the extremity of the cell to the outer border; the median interspaces are crossed by slender lunules, a little oblique, their inner limb the outermost, about as far from the outer border as the bar beyond the cell; the straight half bar in the medio-submedian interspace is at right angles to the nervure. Beyond the mesial band is a row of round black spots, similar to those in *A. cybele*, and enclosing in each interspace, between themselves and portions of the mesial band, distinctly (♀) or scarcely discernible (♂), large, oval, clear spots, the reverse of the extra-mesial band of silvery spots on the under side. Outer border margined with black as on the fore wings, but the middle fulvous line in the medio-submedian interspace is broadened to half the width of the bordering and generally extends somewhat over the submedian and sometimes faintly, or even distinctly, along the whole margin; nearly seated upon the margin, are well-formed black lunules; fringe buff or whitish, interrupted broadly but not suddenly with black at the nervure tips.

Beneath: *Fore wings* conforming almost exactly with the coloration and markings of the under surface of the fore wings of *A. aphrodite*, with such exceptions as the differences in the upper surface would naturally require, and with the following exceptions: the bar bordering the outside of the cell does not usually protrude so far

apically on the subcosto-median interspace as on the upper side; the outer border is dark cinnamoneous, more or less enlivened with buff (but sometimes not at all) along the middle of the wing, and especially near the middle of the interspaces; below the middle median nervure the margin is almost entirely buff or orange buff, with a cinnamoneous line marking its interior border, but fading out before attaining the submedian nervure; fringe as above. *Hind wings* very dark brownish red, the female slightly darker than the male; a streak of buff follows the upper edge of the costal nervure beyond the precostal nervure, flecking also both edges of the subcostal and median nervures as far as the limit of the cell, and the submedian nervure for half its course, forming smaller or more distinct patches of the same in the middle of the cell above, and at the base of the subcostal interspaces, and often supplanting the normal silvery spot beyond the cell and filling the base of the median interspaces with powdery scales; these are also found throughout nearly the whole of the submedio-internal interspace; in the female this buff is usually more or less decidedly tinged with greenish; the basal third of the costal border and the whole of the inner margin as far as the tip of the submedian nervure, is edged with silvery; the basal silvery spots are as in *A. aphrodite*; beyond is a curving row of silvery spots, normally five in number, shaped and bordered as in those of *A. aphrodite*, but the second—that in the upper subcostal interspace—and the external fragment of the cellular spot are frequently buff, instead of silvery; the extra-mesial and submarginal rows of silvery spots are exactly similar to those of *A. aphrodite*, the spots of the former row tipped externally with small roundish spots of very dark brownish red, darker than the prevailing color, occasionally, in the female, greenish; the outer row is edged exteriorly with a narrow black line, and interiorly with a broad, dark, brownish red border; between the two rows is a pretty broad buff belt, partaking of the irregular nature of that of *A. aphrodite*, but broader, having the general average breadth of an interspace; outer border reddish brown or cinnamoneous, enlivened along the middle, but not next the nervures, with buff blushes; fringe as on upper surface.

Abdomen as in *A. aphrodite*. Appendages of male (33: 36): hook of the upper organ of equal depth throughout and slenderer than in the other species; tip considerably and delicately uncinat, but scarcely aided by the excision of the nuder surface. Clasps scarcely twice as long as broad, the apical half curved a little upward, of nearly equal breadth throughout; upper border with a considerable abrupt rounded lobe near the base, a slight angulated median one and the upper hinder angle produced to a broad lobe, a little and obliquely truncate above where it is bristly, and in general having a slight forward direction; the hinder edge of the clasp is broadly rounded with a slight rounded prominence in the middle; upper process as in the previous species but shorter, being scarcely three times as long as broad.

Measurements in millimetres. Length of tongue, 13 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	27.	29.	30.	31.	31.	34.5
antennae.....	13.25	14.	14.	14.	14.	15.
hind tibiae and tarsi..	9.15	10.	10.	10.25	10.25	10.5
fore tibiae and tarsi..	2.5	4.	3.5	4.	4.	4.75

Described from 18♂, 3♀.

Malformation. In one specimen examined, the subcostal nervules of the fore wing are peculiar, the third superior nervule being removed toward the second and the fourth toward the outer border, so as to make the origin of the third and fourth at about equal distances from each other, the apex of the cell and the outer border.

Aberrations. A. A. CHEMO. Mr. Albert G. Davis has sent me an interesting suffused female of this species, taken July 1, 1887, at Lake Chemo, ten miles northeast of Bangor, Me., "flying with the ordinary form of *A. atlantis*, in a sunny glade in the woods." The whole appearance of the insect is changed, and it has taken on a most funereal aspect. The entire upper surface has for a ground color a purplish black,

relieved by one or two costal markings, and a submarginal series of longitudinal, more or less obscured, fulvous dashes; these dashes occupy only about half the width of the interspaces and extend from the normal submarginal fulvous spots preceded by the black lunules, to and including, as if fulvous, the preceding series of round black spots; the black lunules are wholly obliterated; the black spots either form (usually) a fuscous cloud obscuring this end of the band, or, in the median interspaces, are more or less distinct and black. The front wings retain in an obscure way the large transverse fulvous bar in the middle of the cell and some the fulvous lines near the middle of the costa, but the marginal markings are wholly obliterated. *Beneath*, the brownish red base of the hind wings suffuses most of both the wings, but is somewhat infuscated. On the front wing it forms a large triangular patch depending from the costa, at the inner edge of which the middle fulvous bar of the cell is undisturbed, as is also that at its tip; the inner lower fourth of the wing and the greater part of the lower half of the outer margin is pale obscure fulvous; the silvery spots are suffused into common pale silvery bars. The basal half of the hind wings including their silver spots is nearly normal, excepting for the obliteration of the buff, but the two outer rows of silvery spots have amalgamated into large triangular bars, the base outward, occupying the place of and entirely obliterating the pale buff submarginal band, the entire ground being of a uniform smoky brownish red; moreover, the black scales which form the inner margin of the inner of these two normal rows of silvery spots, as well as the inner margin of the similar spots of the basal half of the wing, have become spread into distinct rows of roundish, dark fuliginous spots, wholly independent of, though touching the spots on which they are normally dependent. The outer row of suffused silver spots is greatly obscured in the subcostal interspaces; the premarginal buff line is nearly obsolete. Length of the fore wing, 32 mm. The specimen is now in the Cambridge Museum of Comparative Zoology.

Another specimen, but a male, collected at the White Mountains by Mr. Morrison, shows a slight suffusion, but on the upper side of the fore wings only, the broken mesial band being suffused with that crossing vaguely the extremity of the cell and the base of the median nervules, forming a broad black belt relieved only by a few fulvous blotches. Length of fore wing, 30 mm.

Secondary sexual distinctions. The whole of the submedian and lower median nervules, excepting the base and tip, the whole of the upper two median nervules excepting the apical fifth, and of the lower two subcostal nervules excepting the apical third are covered in the fore wing of the male with blackish fuscous raised scales as in other species of this genus. These partially conceal the androconia, (46: 14) which differ from those of *A. cybele* in being smaller and stouter, and from those of *A. aphrodite* in the greater length of the apical fringed portion, which occupies about one-third of the whole scale and tapers regularly to a point; they are about one-sixth of a millimetre in length; the basal third is black, the rest pellucid. The long hairs on the hind wings above the subcostal nervure are as in *A. aphrodite*.

Egg (64: 22). Twelve to fourteen longitudinal ribs, well marked and slightly raised above the elevation to which they would be brought by the wave like curve of the interspaces, about .2 mm. apart, all reaching to or close to the summit; cross lines delicate, especially in the middle, more distinct next the ribs, and visible across the ribs themselves, about .045 mm. apart. Surface covered with very minute, rugulose circular pits, separated from one another generally by twice their own width, the centres about .006 apart, the intervening scarcely higher portion smooth and glistening. Micropyle rosette (67: 13) about .03 mm. in diameter, composed of from 16-18 cells with thick walls, the inner ones roundish pyriform, about .0125 mm. in diameter and about half as large as the transversely elongated centre ones. Color, honey yellow at first, flecked heavily afterwards with reddish brown; height, .8 mm.; breadth near base, .75 mm.; at summit, .22 mm.

Caterpillar. *First stage.* Head shining castaneo-piceous, with more than a dozen slender, pale, tapering and pointed, sparsely spiculiferous hairs, variable in length, but shorter than those of the body, regularly arranged and arising from very minute warts.

Body pretty uniformly fusco-luteous, the high warts black, the hairs fully as long as the width of the body, pale luteous, slightly infuscated next the very base, and with distant spicules. Length of body, 2.5 mm.; of hairs of body, .33 mm.; width of head, .33 mm.

Second stage. Head black with black hairs. Body brown-green, the tubercles and spines black; beset with many short, divergent, black bristles. Length, 2.8 mm. (After Edwards.)

Third stage. Head as before. Body gray-black with a green tint over the dorsal surface; beneath pale green; tubercles pale yellow, the spines and their bristles black. Length, .4 mm. (After Edwards.)

Fourth stage. Head reddish yellow, more yellow behind. Body gray mottled with black; a double dorsal stripe of gray; tubercles supporting black spines dull yellow in the laterostigmatal and infrastigmatal series, black on the inner and yellow on the outer side of those of the laterodorsal series. Length, 8 mm. (After Edwards.)

Fifth stage. Much as in the preceding stage. Length, 12.7 mm. (After Edwards.)

Last stage. Head dark, becoming pale testaceous behind, the front with scattered hairs. Body dark, velvety purple above, scarcely paler beneath. Basal half of spines pale livid, the spinules nearly half as long as the spines themselves; small papillae-bearing bristles are scattered over the body, with a row of them above the prolegs. (After Packard.) A fuller description is given by Edwards (Can. ent., xx: 2).

Chrysalis (84: 6). Chestnut brown, mottled and irrorate with black, the wings black at the base; the whole surface of the body wrinkled; the spiracles black and conspicuous. (After Packard.) Packard makes no mention of a laterodorsal tubercle on the mesothorax. The drawing by Mrs. Peart (pl. 84, fig. 6) made for Mr. W. H. Edwards and which he allowed me to copy, represents the wings as lighter in color than the rest of the body, brownish luteous rather than chestnut brown, infuscated only at base, and the rest of the body dark brown, the whole wrinkled and black at the wrinkles. Length, 20.5 mm.

There is no need of confounding this species with either of the preceding; it is smaller than they, duller in tint above, has a blackish border to all the wings in both sexes, and a more continuous mesial band on the upper surface of the hind wings; the darker colors of the under surface of the hind wings are deeper in hue than in either of them, while the buff belt is wider than that of aphrodite and narrower than that of cybele; the buff scales on the basal half of the wing also assume more importance than in the other species; finally the costal border of the fore wings does not appear to be quite so much arched.

Synonymy. It is possible, perhaps even probable, that this species is the true Pap. aphrodite of Fabricius, but as it is quite impossible to be certain of it, the names ought to stand as given by Mr. W. H. Edwards, who first clearly distinguished the species in this difficult group. The species were still confounded in the British Museum after the publication of Butler's Fabrician butterflies, as I myself saw, and notwithstanding Butler's remarks on p. 109 of that work.

Distribution (21: 7). This member of the Canadian fauna is abundant throughout all the cooler parts of Canada, and in the east is very nearly limited southwardly by the annual isotherm of 45°, only surpassing it in elevated regions and along mountain chains. Northward it appears rarely to encroach upon the Hudsonian fauna, but specimens are reported

from "Arctic America, Ross" (Brit. Mus.), Fort Simpson and Rupert's Land (Edwards), Hudson Bay (Drexler, fide Edwards, Geffcken), Moose Factory, Hudson Bay (Weir) and central Labrador (Möschler). Westward it has been taken on the shores of Lake Winnipeg (Scudder) and at Crow's Nest (Geddes). A specimen in the British Museum is even reported from British Columbia and Mr. A. G. Butler says it is found in California, but Mr. W. H. Edwards denies its occurrence on the Pacific coast. It is common throughout the whole of Lower Canada (rare at Montreal according to Caulfield). Corneau reports it as common at Godbout River on the lower St. Lawrence, Mr. Couper took it in southern Labrador and Anticosti, Mr. Edwards reports it from Newfoundland, Mr. Thaxter obtained specimens on Cape Breton Island, and specimens from Nova Scotia are in the British Museum, and others have been sent me by Mr. Jones; compared to *A. aphrodite*, however, it is very rare in that province. South of the British possessions and beyond New England it occurs in the Adirondacks (Hill), The Glen, Warren County, a single specimen (Lintner) and the Catskills, N. Y., "not uncommon in certain localities" (Edwards), the higher parts of Pennsylvania (Strecker, Andrews), Lake Superior (Agassiz, Osten Sacken), Michigan (Edwards), Minnesota (Scudder), Wisconsin "rare" (Hoy), Iowa (French) and Illinois (Worthington); and Mr. Mead even found it in the valleys of the Platte and Arkansas, Colorado, at an elevation of 7500-8000 feet.

In New England it is probably common almost everywhere north of Blodgett's isotherm of maximum temperature of 45° for the spring months, or the northern parts of the three northern states, but is really abundant only in the White Mountain district where it wholly replaces *A. aphrodite*. It has been taken at Eastport (Shurtleff), Hallowell "occasionally seen" (Miss Wadsworth) and Norway Me.; Thornton, Shelburne (Faxon, Minot), Littleton (Sanborn) and Jefferson (Scudder), and even at Suncook "not common" (Thaxter), Dublin (Faxon) and Milford, N. H. "very rare" (Whitney); at Mt. Mansfield "not common" (Merrill), Stow "abundant" in 1886 (Miss Soule) and Lake Memphremagog, Vt. (Dimmock); on Mt. Tom and at South Hadley, Leverett and Deerfield (F. H. Sprague), and at Williamstown, Mass., where it is not uncommon (Scudder).

Haunts. The favorite resorts of the butterfly are grassy fields skirting the mountain streams, and it differs slightly from its congeners in preferring sunny woodland nooks to open country. As Mr. Edwards remarks: "It may be seen in company with *arthemis* . . . alighted in small clusters among the damp leaves by the roadside or upon offal of any description. All these species are attracted by any decaying animal matter and a piece of meat or a dead bird or snake has irresistible charms for them."

Life history. The butterfly is single brooded, the larva hibernating as

soon as hatched and before eating. It undergoes its later transformations in the spring, probably awakening at an early period, as the larva feeds upon violets, which are early in leaf. In the White Mountains, the butterfly appears about the middle or latter part of June, but does not become common until the close of the month. In the Catskills, according to Mr. Edwards, the males appear early in June. It is the earliest of the species of *Argynnis* in any given locality. The butterfly continues abundant until the middle of August and is still upon the wing in September. Fernald is certainly mistaken in saying that in Maine it "is on the wing from the middle of June to the early part of July" only. The eggs are laid during the latter part of August, when the numbers of the butterflies begin to diminish. Miss Soule sent me some laid in Stow, Vt., on August 22. Mr. W. H. Edwards obtained them in the Catskills August 28-31, and all I have had were laid at about the same time. I have opened old and worn females at the White Mountains the middle of August, and found the eggs only partly developed; later, on August 19, I have found them very nearly ready to be laid. The eggs hatch in a little more than a fortnight* and the caterpillars go immediately into winter quarters. Of some which Mr. Edwards kept over the winter on ice and brought out again in West Virginia, March 21, one moulted April 15, the second moult was passed by different caterpillars April 25-29; after which one caterpillar, the only one carried to chrysalis, moulted successively, on May 9, 19 and 25, and changed to pupa June 3. The length of the several larval stages, not counting the wintering one, was 10, 14, 10, 6, and 9 days. The chrysalids attach themselves to the under side of logs on the ground and in similar places.

Habits, etc. The butterfly is wilder and more difficult to capture than the allied New England species, which it resembles closely in its flight.

The male has a very perceptible odor which I found it difficult to determine; it seemed to me at first to have somewhat the fragrance of the pine woods; but on applying to Miss Soule, she at once said it was the odor of sandal-wood, which exactly describes it. She added that specimens she had brought into her room at the mountain hotel made it seem close, and a friend who called inquired on entering: "Why! do you bring your sandal-wood box up here?" The odor is apparently equally strong in new and old specimens, and arises from the fringed androconia as I have found by careful tests. It is often retained for months after death by specimens enclosed in papers.

The male follows the female closely, even long before oviposition. The female, when wearied with flight from its pertinacious mate, will rest with erect wings motionless upon the ground; its mate immediately takes position beside it, distant about half an inch or an inch on one side and behind

*Some laid August 21-22 and sent to West Virginia hatched a little sooner, September 3.

it. The female in moving makes a quick start forward for a few steps, then the male does the same, and here, with wings erect, he keeps up a slight quivering agitation of the wings until his consort departs, when in an instant the pursuit is renewed.

When it alights in the road, it rests with wings fully, flatly expanded. Geddes states that he observed it in the mountains of the Canadian north west alight on the upright trunks of trees, head downward. An imprisoned specimen resting for the night on a vertical surface took the opposite position, with the trunk somewhat oblique, the wings closely shut, the front wings tucked well between the hind pair, the abdomen drooping between them, and the antennae, divaricating about 100°, on a line with the upper plane of the thorax.

Desiderata. The early history of this species is almost wholly unknown, the different stages of the caterpillar and the chrysalis never having been adequately described. The flight and postures of the butterfly, though undoubtedly differing somewhat from those of the other species, are not fully described; and it remains without explanation why so long a period elapses between the first appearance of the imago and oviposition. For how long a time are males only on the wing?

LIST OF ILLUSTRATIONS.—*ARGYNNIS ATLANTIS*.

<i>General.</i>		<i>Imago.</i>	
Pl. 21, fig. 7.	Distribution in North America.	Pl. 4, fig. 6.	Male, both surfaces.
	<i>Egg.</i>	33:36.	Male abdominal appendages.
Pl. 64, fig. 22.	Colored.	39:6.	Neuration.
67:13.	Microptyle.	46:14.	Androconium.
	<i>Chrysalis.</i>		
Pl. 84, fig. 6.	Side view.		

BRENTHIS HÜBNER.

SMALLER FRITILLARIES.

Brenthis Hübn., Verz. bek. schmett., 30 (1816). *Argynnis* (pars) Auct.

Type.—*Papilio hecate* Wien. Verz.

Da jagte jenseits grad' am bunten Strande
Klotilda sich mit einem Schmetterling.
Wohl mochte jetzt das zarte Kind nicht meinen,
Als sie ihn fing, sie fange zwei für einen?

SCHULZE.—*Die bezauberte Rose.*

Imago (54:1). Head large, abundantly clothed with long, erect hairs, longest near the antennae. Front moderately full, most so in the middle, but scarcely surpassing the front of the eyes, least full above; much broader than high, but narrowing inferiorly, just above the middle as broad as the eyes; upper margin projecting broadly between the eyes, the sides of the projection curving around the antennae, but scarcely descending; lower border well rounded. Vertex large, tumid, but not greatly elevated, twice as broad as long, the posterior border broadly rounded, and in the middle squarely docked, the anterior border descending abruptly. Eyes rather large, quite full, naked. Antennae inserted just in advance of the middle of the front, in rather large pits, connected by a rather broad and deep transverse channel, but separated by

nearly the width of the extreme base of the antennae; a little longer than the abdomen, consisting of thirty-three to thirty-five joints, of which the last ten or eleven form a strongly depressed, broad, ovate club, at least five times as broad as the stalk and not more than twice as long as broad, the first two joints rapidly enlarging, and the last five entering into the diminution of size; extremity broadly rounded, interrupted by the little conical projection formed by the apical joint; furnished beneath with a median carina, which extends far on the stalk. Palpi very long and rather slender, barely twice as long as the eye, curving slightly forward, the apical joint not more than one-tenth the length of the penultimate, furnished above and below, the middle joint nearly as much as the others, with a rather thin fringe of forward reaching hairs of nearly uniform length, all in a general vertical plane; and below, exteriorly, with a row of erect, scattered, long and slender hairs, projecting laterally a very little.

Prothoracic lobes not large, almost cylindrical, straight, uniform, the ends equal, as long as high, and four times as broad as long. Patagia very small, somewhat tumid, very broad, almost circular, the posterior portion projecting as a short, triangular, bluntly rounded lobe, the whole not half so long again as broad.

Fore wings (39:7) twice as long as broad, the costal margin very slightly and broadly convex, the apical angle rounded off; outer margin a little convex, generally regular, sometimes a little protuberant about the lower subcostal nervule, the general direction of the border being at an angle of about 45° with the costal margin; inner border straight or very slightly concave, the outer angle rounded. First superior subcostal nervule arising shortly before the apex of the cell; the others at nearly equal distances apart, the third about midway between the apex of the cell and the outer margin; second inferior subcostal nervule arising about one-third way down the cell; the latter considerably less than half as long as the wings and from two to three times as long as broad. Median nervule connected with the vein closing the cell by its last branch, nearly half as far beyond the second divarication of the nervule as that is beyond the first.

Hind wings with the costal border rather largely shouldered and well rounded next the base, beyond nearly straight or very slightly convex; outer border very regularly rounded and pretty full, both angles rounded off; the inner margin not very greatly nor abruptly expanded next the base, beyond nearly straight or slightly convex, with no apical excision or emargination. Precostal nervule directed straight upward, sometimes bent slightly outward at the summit; second subcostal nervule originating at a little distance (♂), or scarcely at all (♀), beyond the base of the first; cell closed. Last branch of median nervule curved considerably toward the lowest subcostal nervule, beyond the cell. No androconia.

Fore legs small, cylindrical, fringed with long hairs on the outer side, much more thinly in the female than in the male; tibiae less (♂) or more (♀) than one-half the length of the hind tibiae; tarsi almost as long as the tibiae, consisting either of a single joint with a produced conical apex and an apical spur (♂); or of five joints, the length of the first fully three-fifths of the whole, the second, third and fourth diminishing regularly in size, the fourth and fifth equal; furnished beneath, at the apex of all the joints but the last, with a pair of short, slender, minute spines, in a naked field; but there are no intermediate spines, nor any along the lower portion of the sides of the basal joint (♀); middle tibiae scarcely shorter than the hind pair, furnished on either side beneath with a row of not very frequent, long, and very slender, somewhat spreading spines, the terminal ones developing into very long, and very slender, tapering spurs; also above and on the sides with numerous similar shorter spines irregularly placed. Tarsi, beneath, with four nearly equidistant rows of short, very slender spines, the terminal ones of each joint a little longer than the others; above, abundantly sprinkled with numerous very short, delicate spines, irregularly disposed, but apparently with a tendency to form longitudinal rows. Claws small, moderately stout, considerably curved, tapering to a blunt point; paronychial bifid, the anterior lobe as long as the claws, very slender, scarcely tapering, finely pointed, curving but little; posterior lobe minute, slender, short; pulvillus broader than long,

its anterior border arched. Upper organ of male abdominal appendages moderately stout; the centrum not so globose as in the other *Argynni*di, the hook slender and small, scarcely as long as the centrum, delicately bifid at the tip. Clasps broad, tapering on the apical half, of varying length, the tip produced to a slender blade, which is twisted so as to appear depressed and incurved; upper process very slender, enlarged a little or spatulate at the tip, and subparallel to the posterior blade of the clasp.

Egg. Somewhat conical sugar-loaf shaped, much taller than broad, but the upper portion a little constricted, the lower two-thirds only of the sides being gently swollen, thickest in the middle of the lower third; the summit squarely truncate, its centre depressed, the base flat; furnished with a considerable number of prominent, equidistant, longitudinal ribs, running from the base to the summit and a little over it, or combining with a neighbor to form a single rib in the narrowest part of the egg; surface between the ribs traversed by delicate transverse raised ridges not so distant as the ribs and quite conspicuous. Micropyle rosette, situated on a sunken floor, made up of delicate little roundish cells, increasing in size very little from the centre outward.

Caterpillar at birth. Head broad, much broader than high, well rounded below, the sides nearly equal and slightly compressed, broadest above, the summit very broadly rounded, furnished with a few long curving hairs. Body tapering a very little posteriorly, cylindrical, furnished on each segment equally with pretty large, conical warts, sometimes arranged in clusters, bearing very long, tapering, delicately spiculiferous hairs, very minutely expanding at the tip into a short cup-shaped club, not so broad as the base of the hair, and longitudinally distributed as follows on either side: a subdorsal row* one to a segment placed anteriorly, a supralateral row one to a segment placed posteriorly, an infralateral row one to a segment placed in the centre, and a substigmatal row with a cluster of five or six bristles placed nearly in the middle. Legs quite long and slender, the claw very little curved, tapering, with a very slight heel at the interior base. Prolegs long and tapering regularly, closely approximate and bearing not very long, semicircular, slender hooklets, arranged in the greater part of a circle, six in number on each leg, possibly seven on the hinder.

Mature caterpillar. Head well rounded, rather squarely cut beneath, the mandibles very protuberant; rather broadly and irregularly arched above, scarcely depressed at the suture, the middle of the sides nearly straight, broadest at the upper part of the ocellar field, equally broad and high, scarcely deeper below than above; triangle half as high again as broad, reaching above the middle of the front. Head covered with frequent, pretty long, nearly straight, bristly, tapering hairs. Second antennal joint half as long as broad, third scarcely more than half as broad as the second, and less than twice as long as broad, abruptly docked and furnished with a long apical bristle. Ocelli six in number, five of them forming a strong curve whose convexity is forward and a little upward, at nearly equal distances apart, the second and third counting from above, nearest together, the others distant from each other by less than half their diameter; the sixth is situated directly behind the fourth and as far from it as the second is from the fifth; the third, fourth and fifth are large and prominent, the others inconspicuous; labrum rather large, prominent, the middle of the front roundly and rather deeply excised. Mandibles large, broad, not very stout, their edge straight, with broad, squarish, scarcely separated teeth. Maxillary palpi with the second joint fully half as long as broad, the third scarcely more than half as broad as the second, but half as long again as broad, the fourth as long as broad and half as broad as the third. Spinneret short, stout, tapering.

Body nearly cylindrical, slightly depressed, equal, furnished with longitudinal rows of tubercles, one to a segment in each row; excepting sometimes an anterior pair, the tubercles are fleshy, stout, rather short, conical elevations, bluntly rounded at the tip and furnished with a large number of not very long needle like thorns, diverging

*Gruber says there is a mediodorsal row in *B. myrina*, but he is mistaken.

nearly at right angles to the tubercles or slightly raised above it. They are arranged as follows: on the abdomen, a laterodorsal series on all the segments, placed a little in advance of the middle, that on the first segment being nearly subdorsal; a suprastigmatal on all the segments placed anteriorly, excepting on the last segment where it is posterior; and an infrastigmatal series on all the segments but the last, also placed anteriorly; on the thoracic segments a laterodorsal series placed in the middle of the segments, that of the first segment being to a greater or less extent longer than any of the other spines and sometimes produced at maturity to a very long, fleshy, equal, tentacular, heavy thread, covered with frequent, short, spinous needles; and on the second and third segments a stigmatal row placed on the anterior extremity. Body covered also irregularly with numerous, very short, needle like hairs, arising from very minute warts. Spiracles small, oval, half as long again as broad. Legs rather small, appressed, tapering, moderately slender, the claws compressed, slender, small, curving somewhat, strongly heeled at the base; prolegs short, moderately stout, tapering a little, the hooklets twenty-five to thirty in number, slender and not very strongly curved, arranged in a double row and separated by a space equal to two or three times the diameter of one of them.

Chrysalis. Viewed from above, the prothorax, head and ocellar prominences are equal in width; the latter project conically a little at the outer corners, separated very broadly by the front of the head, which is squarely truncate or else very broadly concave; viewed laterally they are also a little prominent, especially at the lower corners; they are connected by an obscure ridge along the lower front of the head and their extreme base is tumid below, laterally and above; excepting for the tumidity of the lower surface, the angle formed by the front and summit of the head is about 70° . Body a little constricted between the prothorax and mesothorax; mesothorax pretty strongly arched longitudinally, the anterior portion of the posterior half elevated to a pretty high, longitudinal, median ridge, its anterior slope shorter than the posterior when the curve of the segment is left out of account, transversely rounded at summit, the sides sloping at an angle of about 50° , continued anteriorly as a dull equal median ridge to the end of the segment; front of the body from the base of the palpi to near the tip of the wings a very little concave; basal wing tubercle rather prominent, conical, curved slightly forward, with a slight ridge down its inferior posterior surface; supernumerary tubercle very close to the basal one, separated from it by a rather deep rounded angulation, the tubercle a compressed longitudinal ridge, well rounded longitudinally, its anterior shorter than its posterior curve. Wings a little protuberant at tip but with no tubercle; a laterodorsal series of stout, blunt, conical tubercles on the middle of the thoracic and first to seventh abdominal segments, largest and quite large on the third abdominal segment, those in front of nearly equal size, excepting that on the mesothorax, which is small, those of the fourth abdominal segment smallest, very small; beyond increasing in size regularly, but all broader and lower in proportion than the others, at least on the basal portion; the most elevated portion of the tubercles placed toward their anterior edge, at least in advance of the fourth abdominal segment. A pair of very small, rounded, suprastigmatal warts a little in advance of the middle of the second to seventh abdominal segments. Preanal button bounded laterally by moderately broad, low, equal, scarcely curving walls, each terminating anteriorly in a blunt, slightly appressed, nearly recumbent tubercle; cremaster viewed from above very short, tapering, as long as its narrowest breadth, scarcely hollowed; on a side view, expanding rapidly, especially beneath, as long as its greatest breadth, the area for anal hooklets subtriangular, longer longitudinally than broad, its base anterior. Body covered very sparsely with exceedingly delicate, short hairs, invisible to the unassisted eye. Hooklets short, slender, compressed, the stem straight, the crook considerably enlarged, bent roundly at right angles, the pointed apex very short.

Distribution. This group is even richer in species than *Argynnis*, and has a wider geographical extension, embracing not only the north temper-

ate zone above Latitude 60°, but also the contiguous arctic* and subarctic regions and even that portion of South America which lies south of Latitude 35°; i. e., beyond the limits of continental extension in the Old World. In the north temperate regions few of the species reach the southern limits attained by most of the species of *Argynnis*, and of these few, a number are confined to elevated districts; for *Brenthis* has its centre of development on the northern confines of the temperate zone. Several of the species are supposed to be common to both hemispheres, but such are wholly restricted to the subarctic or arctic regions. Apart from these, the genus is less richly represented in the New than in the Old World. Three species only are found in eastern North America south of the St. Lawrence; two occur in nearly equal abundance throughout New England, while the third is limited to the subalpine regions of its northern mountainous district.

General appearance. The butterflies are rather below the medium size; their wings closely resemble those of *Argynnis* in the design and coloration of the upper surface, but within the mesial band of the hind wings, the base is traversed by a net work of many irregular markings; the under surface of the latter not only differs from the pattern of *Argynnis*, but also shows great diversity among the species, as may be seen by a comparison of those described below. The ground color is reddish brown, traversed by a broad, somewhat irregular, black edged, intra-mesial band, usually bent in the middle, and either simply paler than the ground color or silvery, or in places (especially near the middle and next the costal and inner borders) dashed with white or silver; there are a few pale or silvery basal spots, while in the middle of the outer half of the wing the maculations of the upper surface are repeated and sometimes preceded by an interrupted pale or silvery band; there is a submarginal series of dark lunules, sometimes followed exteriorly by white or silvery spots.

Life history. The insects of this genus, which ally themselves to the Melitaeidi in many ways and appear to borrow from them a tendency to lethargy while in the caterpillar stage, seem to present among themselves greater differences in habit than occur in any other similar group of butterflies, the central European species differing considerably from those of the United States, though all the known species, whether European or American, winter as only partly grown caterpillars. The European butterflies are single-brooded in the cooler parts of their range, and double in the warmer, the second brood always being much weaker in numbers. Their history was first traced, more than sixty years ago, by a French naturalist, whose statements have since been neither verified nor contradicted,

* Two or three species have been obtained from the highest latitudes at which insects have been collected, namely between Latitude 81° 30' and 82° N.

and as this history is of great interest, especially in comparison with that of our New England species, we add a translation of the original memoir.* At the beginning of May, 1819, says this writer:†

A female euphrosine laid eggs, which, in ten or twelve days, gave birth to little caterpillars about two millimetres long, which I fed with violet leaves. After moulting three times they showed signs of uneasiness, stopped eating and hastened to attach themselves here and there to the sides of the vessel containing them. At first, I thought they were preparing for a fourth moult, but I was soon undeceived. Their body contracted, they became motionless and stiff as if dead. Yet the season was little advanced and as they had not lacked select food, according to their taste, I did not know how to account for this strange fact. I disturbed them with a feather; most of them scarcely gave a sign of life. I supplied them with a superabundance of food, I exposed them to the sun, placed them in the open air, etc.; five or six of them changed their position, but partook of no nourishment; they again became quiet and fell once more into a lethargic state. I kept them more than a month in this condition. At last, wearied with not seeing them resuscitate. I threw them out of the window, blaming the fate which had thus deprived me of the opportunity of following the history of these caterpillars, which up to this time I had cared for with peculiar affection.

This unexpected result having caused me to imagine that these caterpillars would only thrive well in places where the maternal instinct freely deposited their germs, I made no further attempt to rear them, when an event inspired me with quite different ideas and projects.

Three caterpillars of *Arg. dia*, which were born in the early days of September 1825, concealed themselves under dry leaves, at the end of October, in the same way as those of euphrosine had done. This similar habit enlightened me, made me see my mistake in abandoning the latter. I then determined to raise others, resolved to await with more patience the natural destiny of my marmotic caterpillars. The mistake which I made in 1819 was principally occasioned by considering the time at which the torpor occurred. I did not then know any caterpillar which behaved in such a way at the beginning of summer; but what rendered the point I mention more inconceivable to me was that I knew very well that *Arg. euphrosine* was on the wing twice a year in our districts—first in May, afterwards in July and August.

How, in fact, could one fully understand a lethargy overtaking animals in healthy condition, only half grown, and which moreover had fine weather in which to accomplish all their changes? Surely, I was not unreasonable in believing that these insects could reach their full development during the warm weather. What then had so deceived my hopes? Doubtless my wards had not been carefully nursed in a natural way; this was my constantly recurring thought.

As regards the caterpillars of *dia*, one could scarcely be mistaken. I readily understood the cause of their retirement: these larvae, warned by the first approach of cold that they could not attain the perfect state before the coming spring, were preparing for hibernation like many other insects of very different species. This was confirmed the following year by the arousal and continued development of my three caterpillars of *dia*. After noticing this I awaited with impatience the return of warm weather to solve the question about *Arg. euphrosine*, which I had not considered for six years.

* I had not seen the original of this memoir until after the publication of "The curious history of a butterfly" (*Amer. nat.*, Sept., 1872).

Besides the species upon which Vaudouer experimented, *B. freija* is said to winter as a caterpillar 20 mm. long, and *B. selene* in an immature condition, Schilde having obtained

caterpillars from eggs (after 10-16 days) at the end of June, the middle of August and September.

† Vaudouer, *Observations sur la léthargie périodique des chenilles des papillons euphrosine et dia*. *Mém. Soc. Linn. Paris*, vi: 374-378 (1827).

The 22nd May, 1826, I obtained a quantity of eggs of the species. The new caterpillars were like those of 1819. They lived in the same way. They all stopped eating toward the end of June and I was nearly as much astonished at it as the first time. These larvae remained motionless during the month of July excepting a few which moved about as if searching for something. I supplied them with fresh and tender leaves of which they partook sparingly.

The 8th August, seven of these caterpillars appearing to me to have recovered the size which they had at the beginning of lethargy, I placed them apart in a box and provided them with their ordinary food. A little afterward I was sure that their vital functions were in action as before. They grew rather quickly, moulted twice and entered the chrysalis state, becoming butterflies in the course of the same month of August. Nevertheless, the greater number of my euprosine caterpillars were still in their primitive aestival torpor: they continued therein until the approach of spring this year, 1827. At the time of the thaw, which commenced the 26th February, a dozen endeavored to move languidly but partook of almost no nourishment until the temperature became a little higher. Afterwards they increased in size rather slowly, moulted twice, and finally underwent their metamorphoses between the 7th April and 10th May. But the winter, which was long and severe, although late, killed two-thirds of the caterpillars in my entomological menagerie.

The 27th July, 1826, a euprosine ♀ of the second brood furnished me again with a quantity of eggs. The caterpillars moulted three times and afterwards became torpid like their predecessors; only none of them revived the same year. They remained in this lethargic state the greater part of the winter. Their resuscitation took place the 26th February, 1827, that is, at the same time as that of most of the first caterpillars of euprosine, which had remained concealed in dry leaves since the close of June, 1826. In fact these two batches underwent their final metamorphoses together without showing any sign leading one to suspect that some were born later than the others. In closing these remarks I will add that this year, 1827, I wished to confirm anew what I have said. I procured new caterpillars of euprosine which have behaved exactly in the same way as their elders.

It appears from this very explicit account that euprosyne at least is double brooded, appearing on the wing in May and again in July-August; that both broods lay eggs very soon after eclosion; that the caterpillars of the second generation have attained half their size when winter forces them to hibernate, while those of the spring brood, when half-grown (that is, at the hibernating age) fall into a state of lethargy from which most do not recover until spring; a few, however, resume eating and produce the July butterflies,—the progeny of the two broods thus uniting to form the spring butterflies, when the same process is again repeated.

Doubleday (Gen. diurn. Lep., i: 172-173), after giving an abstract of the above memoir, offers the following comments: "In England we rarely see the perfect insects of either *A. selene* or euprosyne in the autumn, but they are more often met with on the continent of Europe. The second appearance of several species of this genus is to be explained by this habit of the larvae, not by their being double brooded. It would be curious to know if the specimens disclosed from the pupae in the autumn have any progeny, and, if so, to learn their history. Probably it will be found that the ovaries of the females are imperfectly developed, and that they consequently never lay any eggs, or that they hibernate and lay their eggs in the spring, as do the *Vanessae*."

Yet Vaudouer plainly says that the second brood of butterflies lays eggs, and even gives the date of their deposition, with the complete history of the caterpillars hatched from them.

Certainly the history of the European *Brenthis* is sufficiently strange, yet that of our New England forms is equally remarkable, both in itself and in its contrast with that of the European species.

The first attempt to trace the history of our native species was made more than fifteen years ago, when the statistics then at my disposal compelled me to suggest a somewhat extraordinary theory, the outlines of which, although no longer tenable, may be here sketched. According to this view, our butterflies are single-brooded, although some of them possess three successive apparitions of the perfect form, and deposit their eggs twice in the course of the same season. This phenomenon was explained by the supposition that there were two sets of individuals, with cycles of changes as independent as though the series were distinct species. These two sets were designated the vernal and the aestival series, according as the butterflies appeared in spring or summer; for the season of the two series do not correspond. The history of the vernal series corresponds in part with that of the double brooded species in Europe, the second generation being produced by uninterrupted descent from the spring butterflies, while the latter are derived from half-grown hibernating caterpillars of the previous year; the eggs, however, being believed to be never developed in the ovaries of the female until many weeks after her eclosion (as in *Argynnis*), the autumnal brood of butterflies dies without issue and therefore counts for nothing, as Doubleday has wrongly conjectured might be the case with the European species. The aestival series, on the other hand, agrees with *Argynnis* almost completely, both in its seasons and the modes by which these are produced, the larvae hibernating as soon as born. The more striking features in the history of this group in America, would then be as follows:—

1. Two sets of individuals whose development is nowhere synchronous.
2. Consequent difference between individuals in their hiemal condition (common to some other butterflies).
3. Slow development of the egg (shared with *Argynnis*).
4. Consequent longevity of imago (shared with *Argynnis*).
5. Premature hibernation of the caterpillar.
6. Abortive attempt on the part of one series to produce an autumnal brood.

Add to this that the European species differ from the American (1) in the rapid development of the egg; (2) in having only a single series of individuals; (3) which is, properly speaking, double brooded; but (4) whose progeny, through the lethargy or premature hibernation of the earlier brood of caterpillars, unite in producing the spring butterflies,—and an extraordinary chapter in the history of insects would open before us.

Later observations, however, show that this cannot be the case, and it is even contended by Mr. Edwards—and on the basis of his own experiments alone quite justly—1°, that our species are triple brooded, one brood following another with perfect regularity; 2°, that the eggs are always laid by females fresh from chrysalis; 3°, that the caterpillars are not lethargic in the warm season; and 4°, never winter immediately after leaving the egg.

Mr. Edwards's observations were made almost entirely on *B. myrina*; my own and that of my correspondents mostly on *B. bellona*; but it is hardly so probable that the two species differ markedly in their life histories as that the history of either of them may vary under changed circumstances, or even in what appear to be identical circumstances, as was the case with *B. euphrosyne*, under the eyes of Vaudouer. For in contradistinction (but not necessarily opposition) to Mr. Edwards's conclusions I have observed that not only females fresh from the chrysalis, but those which must have been flying several weeks, often have the eggs in their bodies quite undeveloped; that caterpillars are often lethargic in the warm season, the phenomenon having been observed in several lots in two different summers; and that caterpillars hatched in September, and even early in September, may very often hibernate directly from the egg.

My conclusion from all the facts now at hand is that the butterflies should be regarded as partially triple, partially double, and possibly partially single brooded. They fly first in May and June, and thereafter until the middle of September may be found on the wing without break, though their numbers are notably reinforced by fresh examples in the latter half of July and toward the end of August. No eggs are known to be laid by the first brood until the middle of June, two or three weeks at least after the appearance of the brood. Some, certainly, of the caterpillars from these eggs develop to form the second flight of butterflies toward the end of July; perhaps all do, as no lethargy has yet been observed in the caterpillars of the spring brood; yet, as it has been observed in the corresponding brood of *B. euphrosyne* in Europe, it is altogether probable that we shall find it here and discover that such lethargic caterpillars may swell the third brood of butterflies, or even the first brood of the succeeding year; for the third brood certainly, and the first also, I am inclined to think, is always more abundant than is the second. Eggs of the second generation are laid in the latter half of July and early in August; they are sometimes fully formed on eclosion of the female of the second brood, and sometimes they are not; sometimes they may be still undeveloped in butterflies which have evidently flown several weeks; but on the other hand, Mr. Edwards has obtained eggs from butterflies not thirty-six hours old. The caterpillars from these eggs may or may not become lethargic when partly grown, and the lethargic caterpillars may arouse before the

end of the season and resume feeding, or they may not, but instead extend their lethargy to hibernation, and enlarge the spring brood of butterflies. The third laying of eggs takes place the last ten days of August and in September, and these eggs are laid partly by fresh females, partly by butterflies of the second brood which have been on the wing until they are ragged and torn to the last degree; and, as in the case of the second brood of butterflies, some of those belonging to the third brood are in no way ready to lay their eggs when they are born, the eggs being developed in their ovaries only as mere pin-points. At the end of August, therefore, we have a very heterogeneous assemblage,—eggs laid by butterflies of the second and of the third broods; caterpillars just born, from eggs of two broods of butterflies; caterpillars partly grown and active, from eggs laid by butterflies of the second and perhaps of the first brood; caterpillars half grown and dormant, from eggs laid by the same; chrysalids from butterflies of the same; and butterflies fresh and worn according as they belong to the third or second brood. The caterpillars from the last batch of eggs may feed until partly grown and then hibernate (Mr. Edwards's observations), or they may hibernate at once on hatching, and it is not impossible, from what I have seen, to believe that they may winter in the egg as fully formed caterpillars.

These general remarks, it should be said, do not necessarily include any other American species than *B. bellona* and *B. myrina*; it is believed that they have equal reference to both of them, though they are sometimes founded almost entirely on observations on only one of these species.

The early stages. In our American species, the eggs, often, as already stated, not laid until several weeks after the eclosion of the butterfly, hatch in about a week. The caterpillars are lively and timid, lying concealed by day and feeding by night, principally on violets, but also on *Arabis*, *Trifolium*? *Hedysarum*, *Fragaria*, *Spiraea*, *Sanguisorba*, *Rubus*, *Primula*, *Polygonum*, *Urtica* and *Anchusa*, and possibly grasses.

The chrysalids hang from seven to ten days. The butterflies are partial to meadow land, wooded fields or open thickets; some species are confined to mountain slopes clothed with a low and scanty vegetation. Doubleday, comparing them with the species of *Argynnis*, says they are insects of slower and weaker flight, rarely rising to any height, and more frequently returning to the same spots; they may often be seen coursing backward and forward along some marshy bit of ground. When the butterflies are at perfect rest, the wings are closely shut, the front pair concealed as far as possible; when expanded, these are brought well forward. The antennae usually diverge at about right angles.

The eggs are short, sugar-loaf shaped, a little constricted on the upper part, furnished with ribs and transverse ridges, as in *Argynnis*.

The body of the juvenile larvae is covered with little conical warts

ranged on either side in four rows, three above and one below the spiracles, each wart giving rise to a single hair or to a cluster of very long, tapering, minutely spiculiferous hairs, expanding into a delicate, cup-shaped club at the tip.

The body of the mature larvæ is furnished with six longitudinal rows of simple mammulae, differently disposed on the thoracic and abdominal segments, each mammula bearing a stout, fleshy, conical, bluntly tipped, aculiferous process, midway in character between the same appendage in *Argynnis* and *Melitæa*. The caterpillars are usually of some gray tint, marked with blackish lateral blotches or longitudinal bands; the spines sometimes differ in color.

The chrysalids are less angulated than those of *Argynnis*, but like them are strongly constricted in the middle; the dorsal portion of the third abdominal segment is considerably elevated and surmounted by the highest spines; the abdomen is nearly cylindrical, tapering rapidly only beyond its eighth segment. They are dark brown or gray in tint, varied with darker colors, often with dull metallic spots.

*EXCURSUS XVIII. — GLACIAL REMINDERS: OUR OLDEST
NEW ENGLAND BUTTERFLIES.*

No park—no ring—no afternoon gentility—
No company—no nobility—
No warmth, no cheerfulness, no healthful ease,
No comfortable feel in any member—
No shade, no shine, no butterflies, no bees,
No fruits, no flowers, no leaves, no birds,
November!

Hood.

THAT a vast sheet of ice once covered New England has been so long known as to be common intellectual property. The great mass of drift which covers the entire face of the country is too conspicuous to be overlooked by any observing person. That we have indications of a former ice period in the present inhabitants of the district is perhaps not so well known by all. That such should be recognized among the butterflies appears at first blush surprising; yet a careful investigation of the butterfly fauna of New England, and its comparison with that of neighboring parts of the country, show that the nearest allies of no inconsiderable portion of our butterflies now exist in the far north, in regions where the summer still retains the retarding influence of the frozen zone, or they may be found still feeding close beside the existing glaciers of arctic lands. To mention only the most conspicuous instances which we have, we would recall the two butterflies referred to in a former excursus, as now found exclusively upon the barren summits of the White Mountains, and at no other point in or near New England.

The most striking feature in their occurrence is the fact that the genera into which these two butterflies fall have an altogether special interest of great significance in this connection; for they are exclusively or very largely arctic, and there are but three other such genera known in the whole butterfly world. These others are *Erebia*, of which there are some examples in subarctic America and in the Rocky Mountains; *Agriades*, which comes no nearer to us than Labrador, and is found again in the high mountains of the western half of our continent; and *Eurymus*, which is less exclusively arctic than the others, having representatives also over almost the entire globe, excepting in tropical countries, and of which we have three species in New England, one of them subarctic. *Oeneis*, the genus to which one of our Mount Washington forms belongs, occurs elsewhere only in high mountain regions, and, with but one or two exceptions, beyond forest limits, whether toward the pole or the zenith. Several species occur among the mountains of our west, one is found in the Alps of Switzerland, and one in the Himalayas. *Brenthis*, however, the other White Mountain genus, while occurring as far north as butterflies are known (two or three species having been found by the very shores of the Arctic Ocean, in Greenland and Grinnell Land), is represented more largely by species occurring in the temperate zone, and we have in New England itself two of such species. In keeping with this distribution of these genera, the White Mountain *Oeneis* is not only confined to the barren summits of the range, but even, as we have found, to the higher parts of this region, although its food plant, *Carex*, is found everywhere below the forest. The White Mountain *Brenthis*, on the other hand, rarely or never occurs in the same district with *Oeneis*, being almost wholly confined to the lower half of the barren region. Its food plant, though not known, is presumed to be violets, which are found in scanty numbers in the strictly alpine district, a single species being found in favorable spots; but they are sufficiently abundant in the subalpine zone.

These two butterflies, then, may be looked upon as the oldest inhabitants of New England, which followed the retreating ice sheet in its progress northward, and whose brethren, thought by some to be even forms of the same species, still cling to the borders of the ice region of the north. They were the first of their tribe to fly over the barren fields of New England when the earliest verdure began to follow the withdrawing ice, and moving with it step by step, were at last, some of them, beguiled by the local glaciers which remained in the White Mountain region long after the main glacial sheet had left these mountains far in its rear, and until connection with the main body was finally cut off. As one of our writers has expressed it: "Return became at length impossible. They advanced behind the deceiving local glaciers step by step, up the mountain side, pushed up from below by the warm climate, which to them was uncon-

genial, until they reached the mountain peak, now bare of snow in the short summer. Here, blown sidewise by the wind, they patiently cling to the rocks; or in clear weather, on weak and careful wing, they fly from flower of stemless mountain-pink to blue-berry, swaying from their narrow tenure of the land. Drawn into the currents of air that sweep the mountain's side, they are forced downwards, to be parched in the hot valleys below. Yet they maintain themselves; they are fighting it out on that line" (Grote).

It may here be remarked that botanists have not yet distinguished two zones of life above the trees in our White Mountains, but only between those plants that are found exclusively in that region or in the high north, and those which, while found there in greatest abundance, are also found decidedly out of it. But my own casual observation of the comparative abundance of certain flowers over the districts I have distinguished as upper alpine and lower alpine, leads me to believe that a careful survey of the field would bring one to the same conclusion as I have drawn in the case of the butterflies. Moreover, Agassiz noted many years ago certain distinctions, as the following extract from his "Lake Superior" shows: "Above this level the mountain is naked, and many fine plants make their appearance which remind us of the flora of Greenland, and many of which grow on the northern shores of Lake Superior, such as *Arenaria groenlandica*, *Vaccinium caespitosum*, *uliginosum*, etc. The summit of the mountain, at the height of six thousand two hundred and eighty feet, produces several plants which have no representatives south of Labrador. Such are *Andromeda* [*Cassiope*] *hypnoides*, *Saxifraga rivularis*, *Rhododendron lapponicum*, *Diapensia lapponica*." (p. 186). The phenogamous vegetation of the whole district is indeed pretty well known, but it would be well to prepare full catalogues of the plants found in every distinct centre of alpine vegetation, with their comparative abundance at each place. Thus in the immediate vicinity of Mount Washington we should have separate comparative lists of plants of the elevated plateaus, of the borders of the Lakes of the Clouds, the base of the southerly cliff of Mount Munroe, the boggy area above the Fall of the Thousand Streams, the neighborhood of the snow field in Tuckerman's Ravine, the Alpine Garden, etc., with special notes upon the heights at which they are found as nearly exact as possible. The study, too, of the other insects of this region is just as instructive as is that of the butterflies or the plants. Thus among the moths of the genus *Agrotis* alone, Mr. Grote finds no less than three species, *imperita*, *islandica* and *carnea*, which occur, besides on these lofty summits, only in Labrador and in Lapland or Iceland, while a considerable number of other moths and of Coleoptera are also known, inhabitants otherwise only of the high north.

It will naturally be asked how it is possible that insects, and especially

such delicate organisms as butterflies can maintain themselves in such a bleak and inhospitable region as the summit of the White Mountains, where a Greenlander would find it impossible to live in comfort, inasmuch as he would be exposed not merely to the cold to which he is no stranger, but to the fiercest and most biting winds, with an amount of humidity accompanying them which would seem to be almost fatal to existence. In the case of our two butterflies it is tolerably certain that both of them pass the winter in the caterpillar stage, concealed in crevices of rocks beneath the mantle of snow, so that they are free from the sweeping wind, and have nothing but the rigors of the extremely long and cold winter to encounter. For protection during the brief existence of the butterfly life itself, there is a very plain provision on the part of nature in the protective colors of the wings. Especially is this the case with the *Oeneis* which, on alighting (which it ordinarily does on the bare gray rocks), invariably closes its wings back to back and settles upon one side as if reclining, the point of the wings away from the wind, where it clings to the roughnesses of the rocks, and is seldom blown from its foothold. In this position the peculiar gray mottling of the under surface of the exposed portions of the wings so closely resembles the gray rocks themselves, flecked with minute brown and yellow green lichens, that it is almost impossible to discover one in its resting place unless one has seen it alight. The resemblance is of a very marked character, and is unquestionably a great means of protection. Moreover there are undoubtedly some physical peculiarities which it has gained from its long life upon the mountains which unfit it for residence at a lower level. For as has been seen in the discussion of this species, it cannot, while in the imago state, bear transportation so much as three thousand feet vertically to the base of the steeper slopes, at least if this transportation is effected in a rapid manner. Indeed their efforts at flight under such circumstances are so pitiable that it would seem very doubtful if the butterfly hurled deep down into the ravines by the fierce blasts which may at times catch it unawares could possibly remount the steep slopes. That such cases of destruction may occur with so feeble winged a butterfly seems by no means impossible, and I have myself been witness to what was apparently such an instance, when a butterfly starting at my approach was caught by the wind, driven along the edge of the cone of Washington, at no moment in its early voyage far from the level of the ground, to be swept finally high in air, and then be precipitated down Tuckerman's Ravine, whither I was able to follow it for an immense distance as a mere dark speck visible against the white cloud behind it, to finally disappear from vision.

With regard to the *Brenthis*, we have here again a case of protective resemblance, though to a less extent; for in the brilliant red and ashy checkered surface of the under wings, seen when the insect is at complete

rest, we have contrasted colors frequently to be met with in the subalpine region in the latter part of the season when frosts have begun their work. But whether these protective resemblances are very necessary in a district where so few birds are found, hawks and snow birds being almost the only persistent inhabitants, may perhaps be doubted, and the markings which we find on these insects may be only their ancestral inheritance, useful on the arctic barrens where birds are more various and plentiful. The *Brenthis* indeed seems really doomed to destruction. In the scanty numbers that one may find upon the mountain slopes, one sees the sign of their early departure; for, in the many years that I have searched for them with special pains, I have never seen more than a dozen or two specimens in a single day. Yet this is not at all true of *Oeneis*, and one hardly need to be anxious, in our generation at least, concerning its persistence, for the butterfly is as abundant in its native haunts in proper season as almost any of the more favored inhabitants of lower levels.

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See essays by Mr. A. R. Grote in the *American naturalist*, x: 129, the *Canadian entomologist*, vii: 164, and *Psyche*, i: 76, as well as his *Illustrated Essay on Noctuidae*. See also the papers referred to on p. 134, and Gray's notes on the Alpine floras in the *American journal of science* 1857.

Table of species of Brenthis, based on the egg.

Vertical ribs less than twenty in number.....	myrina.
Vertical ribs twenty or more in number.	
Much more than half the vertical ribs reach the summit.....	montinus.
Much less than half the vertical ribs reach the summit.....	bellona.

Table of species, based on the caterpillar at birth.

Bristles with a slender apical enlargement, the supports of the lateral spicules inconspicuous, scarcely projecting.....	myrina.
Bristles with a considerable apical enlargement, twice as broad as its neck, the supports of the lateral spicules not inconspicuous, giving it a somewhat jagged appearance.....	bellona.
(Montinus unknown.)	

Table of species, based on the mature caterpillar.

Laterodorsal tubercles of the first thoracic segment many times longer than the others.	myrina.
Laterodorsal tubercles of the first thoracic segment scarcely longer than the others...	bellona.
(Montinus unknown.)	

Table of species, based on the chrysalis.

Laterodorsal tubercles of abdomen almost uniformly conical, those of the first segment smaller than those adjoining.....	myrina.
Laterodorsal tubercles of abdomen constricted beyond the middle, bluntly rounded at tip, those of the first segment of the same size as the adjoining.....	bellona.
(Montinus unknown.)	

Table of species, based on the imago.

Mesial and marginal series of spots on under surface of hind wings lustrous silvery...**myrina**.
Mesial and marginal series of spots on under surface of hind wings often brighter than the ground but never distinctly lustrous.

Ground color of under surface of hind wings cinnamon-red, the paler, marginal markings of same distinctly white.....**montinus**.

Ground color of under surface of hind wings clouded with purple, the paler, marginal markings of same obscure.....**bellona**.

BRENTHIS MYRINA.—The silver bordered fritillary.

[The pearl bordered fritillary (Gosse); *Myrina* butterfly (Harris); silver bordered fritillary (Scudder); silver bordered butterfly (Maynard); black spotted butterfly (Ross).]

Papilio myrina Cram., Pap. exot., ii: 141, pl. 189, figs. B. C. (1779).

Argynnis myrina Hübn., Verz. schmett., 30 (1816); —Boisd.-LeC., Lep. Amér. sept., 155-156, pl. 45, figs. 1, 2 (1833); —Kirb., Faun. bor. amer., iv: 290 (1837); —Morr., Syn. Lep. N. Amer., 45 (1862); —Harr., Ins. inj. veg., 3d ed., 286-287, fig. 112 (1862); —Pack., Guide ins., 253-255 (1868); —Saund., Can. ent., i: 55-57 (1869); —Edw., Ibid., vii: 189-195 (1875); viii: 161-163 (1876); ix: 34 (1877); Pap., i: 134-141 (1881); —Middl. Rep. ins. Ill., x: 82 (1881); —Coq., Ibid., 161 (1881); —Fern., Butt. Me., 42-43, fig. 15 (1884); —Gruber, Pap., iv: 91, pl. 3, figs. 34-35 (1884); —French, Butt. east. U. S., 161-163, fig. 42 (1886); —Mayn., Butt. N. E., 25-26, pl. 4, figs. 29, 29a [not named] (1886).

Melitaea myrina Say, Amer. entom., iii. pl. 46 (1828?); Entom. N. Amer., ed LeConte, i: 104-105, pl. 46 (1859).

Brenthis myrina Herr.-Schaeff., Prodr. syst. Lep., i: 73 (1865); —Scudd., Butt., figs. 3, 9, 131, 132 (1881).

Argynnis myrinna Gruber, Jen. zeitschrift, xvii: 479, pl. 8, figs. 34-35 (1884).

Argynnis myrissa God., Encycl. méth., ix: 253, 266, 806 (1819).

Papilio myrinus Herbst, Natursyst. ins. schmett., ix: 178-179, pl. 255, figs. 3-4 (1798).

Figured by Glover, Ill. N. A. Lep., pl. 26, fig. 2, ined.

The garden is fragrant everywhere,
In its lily-bugles the gold bee sups,
And butterflies flutter on winglets fair,
Round the tremulous meadow buttercups.

MUNKITTRICK.—*Here*.

Imago (4: 5, 12: 4). Head crossed with black and fulvous scales and thickly beset with long hairs, fulvous at the base, brownish yellow-green beyond; sides behind the eyes mostly pale buff. Sides of palpi white, beyond the middle becoming gradually tinged with orange, and excepting the basal third, becoming more and more specked apically with blackish; fringed beneath with pale fulvous hairs, above with brighter fulvous hairs, mingled with fuscous; the apical joint almost entirely fuscous both above and below, along the lower outer border a spreading fringe of black hairs; inner much like the outer side, but considerably obscured with longer blackish scales. Antennae pale luteous, covered with white and black scales; the white forms a broad, continuous streak on the inner lower border, extending also over most of that side of the club, the black most conspicuous above, but always interrupted at the base of the joints with white; two or three of the basal joints tufted slightly with fulvous hairs; club velvety black, the basal joints marked with white, the last three or four joints above and the whole broad median line beneath, dull orange, beneath somewhat infuscated. Tongue luteous at base, becoming gradually infuscated beyond to a blackish fuscous tint, the extreme tip luteo-fuscous; papillae (61: 39) appressed fabiform, three times as long as broad, longer than half the width of the tongue, broader apically than basally, the tip rounded, with a slender apical cup, from which, nearly filling it, springs a stout, conical, blunt-tipped filament, not half so long as the width of the papilla; they are distant, and arranged in open pairs.

Thorax covered with black scales, concealed by greenish fulvous hairs, more con-

spicuously fulvous on the top of the patagia, the prothorax and the flanks of the metathorax; beneath pale, slightly greenish, buff, tinged with fulvous next the wings. Legs pale luteo-fulvous, the fore legs a little brighter, fringed with pale buff hairs, on the female flecked beneath with white and black scales, the tips of the tibiae and tarsal joints slightly infuscated, the spines luteo-fulvous, slightly infuscated, the spurs similar, their apical half fuscous; claws fusco-castaneous; pulvillus white, with a transverse median black streak.

Wings above fulvous, scarcely at all begrimed with blackish scales even at the extreme base of the wings; the basal half with markings similar in position to those of *B. bellona*, but more slender and generally better defined. Outer border of *fore wings* (39: 7) regularly rounded, inner border very slightly concave. Midway between the mesial stripe and the apex of the wing a vague, blackish fuscous, triangular bar depends from the costal border, never surpassing the penultimate subcostal nervule; there is a very slightly sinuous row of six roundish spots, subparallel to the outer border and of nearly equal size; the outer border of the wing, more broadly above than below, is entirely blackish, its interior edge dentate, the points in the interspaces, and encloses in each interspace a small, indistinct, often obsolete, fulvous spot; fringe pale fulvous, rather broadly interrupted with blackish at the nervure tips. Costal border of *hind wings* slightly convex; outer border intermediate in fulness between the other two species; inner border slightly convex beyond the basal expansion. At about midway between the mesial stripe and the outer border, or a little nearer the latter, there is an arcuate row of six, nearly equal, roundish spots; the outer border and the fringe as on the fore wings.

Beneath: *Fore wings* pale yellowish fulvous, paler toward the apex, the costal border enlivened by a few yellowish and silvery scales, the black markings of the basal half of the upper surface repeated more faintly, the mesial stripe broken into spots; the series of six black spots in the middle of the outer half of the wing is also repeated, the upper three spots being minute and inconspicuous; there is a submarginal series of delicate, sagittate spots, usually black, sometimes blackish cinnamoneous, distant from the outer border by the width of an interspace, seated upon small, sublozenge-shaped, silvery spots, which just fail of reaching the border; the upper two are larger, occupy the whole width of the interspace in which they occur and are tinged with buff; a portion of the subcostal area occupying the apex of the wing, beyond a point midway between the apex of the cell and that of the wing, is generally suffused with a cinnamoneous hue which also spreads down the outer border beyond the sagittate spots, but does not interfere with the markings; the apical spot is bordered interiorly by a vague, buff yellow or ochraceous stripe, and is more or less varied with the same throughout; fringe as on upper surface. *Hind wings* dark cinnamon red, the veins in the apical half of the wing darker; a silvery spot lies near the base of the costal border, at the tip of the precostal nervure, its edge flecked with black scales; at the junction of each of the principal veins a pretty large silvery spot, the middle one smallest, the lower two edged exteriorly with black; in the middle of the cell a rather small, round, silvery spot with a large, black pupil; a premesial series of large, subquadrate, silvery and small, subtriangular, ochraceous spots, the latter at the extreme base of the subcostal and median interspaces, edged externally with blackish cinnamon and sometimes enlivened within with a few silvery scales; the former, in all the other interspaces, edged interiorly and exteriorly with black; the uppermost silvery spot is situated in the costo-subcostal interspace and is seated upon the very base of the first subcostal nervule, both its inner and outer border emarginate; the second is very large, in the subcosto-median interspace, one-third within, two-thirds without the cell, both margins rounded, its longest diameter on the median nervure; the third is a little larger than the first, and of a similar shape, situated in the medio-submedian interspace, resting upon the extreme base of the first median nervule; the fourth is smaller, similar, in the submedio-internal interspace, its exterior margin on a line with the previous; in the interspace next the inner border is an oval, longitudinal patch of silvery; there is an extra-mesial bent row of silvery lunules,

smallest in the centre of the wing and increasing in size in either direction, sometimes flecked above, especially in the lower half of the wing, with black scales, but having an indefinite outline; between these and the intra-mesial band, the subcostal and median interspaces are heavily tinged with ochraceous; there is a marginal series of large, roundish, silvery spots supporting black or dark cinnamoneous, rather slender, sagittate spots, which are sometimes edged above very delicately with ochraceous; the subcosto-median and upper median interspaces are almost wholly bathed in ochraceous from here to the extra-mesial row of silvery spots; nearer the marginal than the extra-mesial row is an arcuate series of small, round, black spots, subparallel to the outer border, obsolescent above and below; outer margin narrowly edged with blackish brown; fringe as on upper surface.

Abdomen above blackish fuscous, the sides more or less enlivened, especially at the tips of the segments, with fulvous scales, and at the tip of the abdomen with fulvous hairs; beneath abundantly besprinkled throughout with fulvous scales, becoming thicker toward the extremity of the abdomen.

Male appendages (33: 33-35): upper organ; hook much more strongly curved than the centrum, generally as long as it; of equal breadth throughout, it tapers in depth regularly to a point, which, viewed from above, is seen to be bifid, hollowed to the depth of the width of the hook. Clasps less than half as long again as broad, as far as the base of the posterior process, which extends from the upper angle as a very long and slender, strongly curving or angulated lobe lying in a horizontal plane and tapering on the apical third to a point which is directed forward and a little inward. The upper process consists of a long, slender and spatulate lobe, also horizontal, but slightly upturned and bent a little inward, its posterior edge minutely denticulate.

Measurements in millimetres. Length of tongue, 7.75 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	17.5	20.5	21.5	20.5	21.	21.5
antennae.....	8.75	10.25	10.5	10.	10.	10.85
hind tibiae and tarsi.....	6.	7.15	7.25	6.75	7.	7.5
fore tibiae and tarsi.....	1.75	2.25	2.25	2.25	2.15	2.5

Described from 28 ♂ 5 ♀.

Aberrations. B. M. NUBES. In the Museum of Comparative Zoology is a male from Sanbornton, N. H., collected by W. Blaney on August 15, 1884, which is a remarkable instance of suffusion. The ground color of the upper surface of the wings is normal, but the black markings are greatly changed. On the *fore wings* there are no markings whatever on the basal half, excepting the transverse bar at the extremity of the cell, and the broader transverse bar in the middle of the same, both of which are normal. All other markings, excepting the longitudinal streak at the base of the medio-submedian interspace, are simply suppressed; this suppression includes the two narrower transverse bars of the cell and the whole of the mesial stripe excepting its outermost member, the bar crossing the subcosto-median interspace, and this is reduced to a minimum. The black markings of the outer quarter of the wing are pretty completely run together, the round spots becoming long ovals and meeting the marginal markings, while the fulvous dots next the margin, though not lost, are subdued, and are also elongated into streaks, especially in the upper half of the wing. On the *hind wings* the cell is completely filled with black, excepting a small, apical, triangular, tawny spot, which does not encroach on the nearly normal black bar closing the cell; the whole of the medio-submedian interspace, as far as the end of the cell, is also, as normally, blackish griseous; but, as on the fore wing, there is nothing left of the mesial stripe excepting, not its outermost member, but that in the lower median interspace, which has here run baseward to meet the basal spots, filling nearly the entire basal half of the interspace. All the other marginal markings have completely overspread the apical quarter of the wing on its upper half, though on the lower half the round spots of the median interspaces have preserved their integrity, while the marginal markings are reduced to a minimum.

Beneath the change is very great, particularly on the hind wings; the ground color is, however, normal; on the *fore wings* there is a repetition of the basal markings of the upper surface (the bar in the middle of the cell with a fulvous centre), but in addition there is a remnant of the mesial band in the medio-submedian interspace; the extra-mesial row of round spots and dots is nearly normal, only wanting in the upper subcostal interspaces, excepting that they are encroached upon outside mesially by the strigose extension of the normally submarginal silver spots, which here are run into longitudinal streaks with a tendency to expand premarginally, and are bordered with buff; on the *hind wings* the suffusion is most interesting and complete; all the silvery spots are completely run together from base to margin, filling, with various widths, all the interspaces and the cell, leaving between them only the cinnamomeous ground, more or less suffused with buff in the basal two-thirds of the wing, and two independent spots which, not being fairly normal to this surface, at least to such an extent, may be looked upon as transfers from above. These are a very narrow, transverse, black bar closing the cell and a central, transverse, oval, black spot in the centre of the cell. Expanse of wings, 42 mm.

I have taken two males, one in the White Mountains, the other in Massachusetts, in which there is a partial suffusion of the black markings, one most conspicuously in the middle of the fore wings above, the other mainly in the outer border of the upper surface of both wings. In the former, nearly the whole of the space included between the mesial stripe and the transverse bar in the outer half of the cell and the V-shaped dash below it, is suffused with black; there is a squarish, fulvous spot just beyond the extremity of the cell, making the suffusion less complete than is the parallel case cited under *B. bellona*, and the under surface does not differ from the type; the outer border of the fore wings is also partially suffused; but this is more distinct in the other instance mentioned, where the outer border of both wings has the interior limits obscured by a begriming of mingled fulvous and black scales, increasing its apparent width, and in which the fulvous spots, usually enclosed within the black margin, are obsolete; on the fore wings the upper round spots in the neighboring series are concealed in the suffusion.

Secondary sexual distinctions. There are no androconia, but a slight difference between the sexes appears in the point of origin of the second subcostal nervure of the hind wings.

Egg (64: 28). Sixteen or seventeen prominent, longitudinal ribs, nearly all reaching the summit, .0085 mm. in thickness, .032 mm. in height, and in the middle of the egg .12 mm. apart; the space between them is hollowed with a regular, equal curve, broken up by cross lines .04 mm. apart; the floor of the cells thus formed is profusely covered with minute, shallow, oval punctures, averaging .0042 mm. in length. Micro-pyle rosette (67: 18) .136 mm. in diameter, composed of a number of irregular roundish or angular cells, of nearly uniform size, the largest .025 mm. in diameter. Color of egg pale, dull, slightly olivaceous yellow. Height, .93 mm.; greatest breadth, .66 mm.; breadth at summit, .27 mm.

Caterpillar. First stage (72: 2). Head (79: 7) shining blackish olivaceous brown, the suture of the triangle marked by a delicate black line, covered with infrequent, long, curving, yellowish brown hairs; ocelli black in a black field; mouth parts and antennae luteous, the jaws reddish at tip. Body pale, dull, nearly uniform olivaceous, a little darker or brownish in the middle of the segments (but all turning green after the animal has eaten), dotted profusely with excessively minute, circular punctulations, which do not cover the warts; warts of the color of the part on which they are seated, tipped with black; the hairs are dull brownish in color, those of the sides straight, those of the upper surface curved forwards on the anterior end of the body as far as the seventh abdominal segment; on this and the succeeding they curve backward; the barbs of the hairs are distant from each other on the same side by usually about twice the width of the hair, and those of opposite sides are emitted nearly opposite to each other. Legs greenish, fuscous at the tip; prolegs greenish. Total length, 2 mm.; breadth of body, .44 mm.; breadth of head, .38 mm.; length of hairs on head, .22 mm.; length of hairs on body, .35 mm.

Second stage. Head black or blackish castaneous, smooth, shining, with a few long black and pale hairs; ocelli black; mouth parts dark luteous. Body marked with pale and darker green, the darker green occupying and surrounding all the elevations, the pale green most conspicuous in a broad dorsal band, interrupted by a darker dorsal spot and a pair of similar subdorsal spots at the posterior extremity of each segment; the paler spots are also found conspicuously in a lateral band on alternate segments, and also below the suprastigmatal row of spines; tubercles blackish green, seated on a dark green elevation, its needles black, the laterodorsal ones of the first thoracic segment not noticeably longer than the others. Legs greenish, marked exteriorly with fuscous; prolegs dusky green, tipped with pellucid. Length, 4 mm.

Third stage (79: 8). Head dark metallic green, with a few scattered blackish hairs. Body of the same general color as in the second stage, but greatly mottled with dull brownish luteous and very pale purplish, the former more conspicuous in spots on the sides of the body between the laterodorsal and suprastigmatal rows of tubercles; the laterodorsal tubercles of the first thoracic segment have become twice as long as any of the others. Spiracles blackish fuscous, with a whitish dot in the centre. Legs black. Length, 11 mm.; breadth of body, 2 mm.; length of anterior spine, 1.25 mm.; breadth of head, about .8 mm.

Fourth stage. The general colors remain the same, both for head and body, as in the previous stage, but all the tubercles excepting the long ones of the first thoracic segment have become pale luteous—those of the thoracic segments a little brighter than the others—with blackish needles. The long tubercles are pale luteous at base, the remainder blackish fuscous; the luteous portion is thickened, the dusky part slender but thickened slightly near the tip, the needles black.

Last stage (75: 2, 3; 79: 9). In colors the insect remains the same, but the tubercles (86: 81) having attained their full development, those of the laterodorsal row on the first thoracic segment are strikingly different from the others, being fully four times as long, in shape much as in the previous stage, about as large at tip as at base, cylindrical or perhaps a little appressed in the middle half, the apex bluntly rounded, the needles about as frequent and as long as on the shorter tubercles, and directed upward at an angle of about 45° with the tubercle. Length of body, 15 mm.; breadth, 3 mm.; length of anterior spines, 2.5; length of other spines, .75 mm.

The laterodorsal tubercles of the first thoracic segment are first noticeably longer than those of *B. bellona* in the third stage, more noticeable from the fact that on the other segments the tubercles of the same row are relatively shorter than in its congener.

Chrysalis (84: 12-14). Head, thorax and appendages brownish luteous, the edges of the wings a little beclouded with fuscous, the centre dashed with blackish, the tibiae tipped with blackish, the antennae marked with pale; back of the thorax occasionally infuscated and the front a little streaked with fuscous. Ocellar prominences separated by a narrower space than in *bellona*, their inner surfaces brownish and united by a narrow brownish band, anteriorly edged with pale. Abdomen blackish fuscous, streaked longitudinally, and on the posterior border of the segments in circlets, with dull brownish luteous; a series of infuscated dorsal spots of brownish luteous, broadening from the anterior to the posterior edges of the segments; laterodorsal tubercles almost uniformly conical; those of the first abdominal segment smaller than those on the adjoining segments; those of the thoracic and first and second abdominal segments glistening throughout like mother-of-pearl; the others yellowish brown, minutely tipped with black, connected with the middle of the anterior edge of the segment by an indistinct pale bluish ridge. Spiracles dull luteous, lips infuscated; cremaster dull reddish. Length, 12 mm.; breadth at ocellar prominences, 2.65 mm.; breadth at basal wing prominences, 4 mm.; breadth at fourth abdominal segment, 3.5 mm.; height at thorax, 3.6 mm.; height at third abdominal segment, 4.25 mm.

Geographical distribution (22: 1). This butterfly is widely spread

over the North American continent, where east of the Mississippi it occupies most of the Alleghanian and Canadian faunas. It is found as far east as Cape Breton (Thaxter) and Nova Scotia, where it is one of the commonest butterflies (Jones): it is abundant along the Atlantic slope as far south as Maryland (Uhler), and has been taken in the Catawba Valley, N. Car. (Bean, teste Uhler), though it does not occur on the Kanawha, W. Va. (Edwards). It occurs in northern but not in southern Illinois.* Westward it has been found as far as Beloit, Wisc. (Chamberlain, Kirtland), Iowa, where it does not seem to be very common, though widespread (Parker, Putnam, Osborn) and even Montana (Edwards) and the Middle Park of Colorado (Mead). Boisduval and on his testimony, W. H. Edwards and Scudder, all record it from California, but no doubt erroneously; Henry Edwards says it does not occur either in California or Oregon, but Strecker gives it from the "southern part of British Columbia." In the north it is apparently found all over the settled parts of Canada proper, extending also to both shores of the lower St. Lawrence (D'Urban, Godbout), to Martin's Falls (Brit. Mus.), Hudson Bay (Weir), to Sault St. Marie, Lake Superior (Bethune), and Nepigon on its north shore (Fletcher). Strangely, it has not been reported at all from the great lake region of British America, north of 50°, where one would expect to find it from its presence in British Columbia, but it must be found there as it occurs at Fort Edmonton on the Saskatchewan (Geddes), and varying a little from the type, abundantly even at Sitka, Alaska.

It is found in nearly equal abundance throughout New England.

Oviposition. The eggs are laid upon the upper surface of violet leaves as well as on the stems, and in freedom I have seen them laid on slender blades of grass in the neighborhood of violets. They hatch in six or seven days, though they sometimes take longer. Some laid at Nepigon, Lake Superior, before July 11, hatched in Massachusetts, where they were brought on the 14th, between July 21 and 23, but I have not known them to be delayed so long when laid with us excepting late in the season when a fortnight is sometimes required. I have received living specimens of the eggs from Messrs. C. E. Hamlin, P. S. Sprague, C. P. Whitney and C. E. Emery.

Food and habits of caterpillar. The caterpillar seems to feed indiscriminately upon all wild or cultivated Violaceae. At eclosion it eats its way out of the upper half of the shell but seldom devours the rest. By day it lies concealed upon a violet stalk or the under surface of a leaf, feeding only by night. When young it eats in little patches

* Say remarks that it occurs as far south as Florida, but this is certainly not true. Boisduval also states that it is found in "some of the Antilles" and Lucas records it from Cuba, but

Gundlach has not found it in the latter island, and its presence in any of the Antilles is in the highest degree improbable.

the parenchyma of the upper surface of the leaves ; at a later period it bites holes entirely through them. It moves very slowly at first but soon learns to wander about with great agility ; it produces little silk, dropping quickly, when disturbed, without spinning a thread.

Life history. This insect passes the winter as a caterpillar, sometimes just from the egg, sometimes when half-grown. As a result of this difference in age, the first brood of butterflies straggles on in the spring instead of bursting upon us in swarms as is the case with some other species. The butterfly usually appears toward the end of May, or considerably later than its congener *B. bellona*, but appears to vary somewhat with the latitude, and especially with the year. The earliest record I have of its appearance is on the 16th of May at Albany (Lintner), where it is then even reported as abundant. I have myself seen it at the same place on the 17th. It is reported from as far north as Ottawa on the 22d, while the first specimens seen in their respective localities were found in other years at New Haven and Boston on the 24th, about Boston on the 27th, 28th and 30th ; in two separate years Mr. Saunders first found it at London, on the 4th of June. Gosse notes its first appearance in Compton as late as June 10, and Professor Hamlin found it in one year for the first time on the 12th of June at Waterville, Maine. Its usual appearance about Boston is in the early part of the last week in May and it becomes abundant early in June, and flies until the next brood of butterflies has made its appearance. Fresh specimens continue to emerge from the chrysalis throughout June, and in such northern regions as the White Mountains and in Maine early in July. The eggs are laid throughout the last half of June and during July, the earliest records being June 15 at Boston, 16 at London, Ontario, and 20 at the Catskills. The eggs hatch in six or seven days though sometimes delayed for nine or even ten days. The caterpillars feed for a month, and a new brood of butterflies appears in the latter part of July, rarely before the 19th or 20th (excepting in southern localities like Nantucket, where occasionally they appear as early even as the 3d of the month, thus completely overlapping in time the later individuals of the brood, a couple of hundred miles to the north), and becomes abundant at the end of the month, continuing to emerge from the chrysalis throughout a part of August, and being found upon the wing in September, when the butterflies of the third brood have made their appearance ; thus repeating the phenomena of the second brood. The eggs of this brood, being often laid immediately upon eclosion of the butterfly, may be found throughout the latter half of July and the early part of August, and being also found undeveloped in some until the butterfly has flown for some time, are also laid throughout the latter half of August and in September. Whether any or many of the caterpillars become lethargic when half-grown is not known ; none have been observed by Mr. Edwards in his

repeated experiments upon this butterfly in the Catskills, and I have but a single instance, of which I am not quite positive, in my own experiments, which have been many fewer upon this butterfly than upon *bellona*. The eggs of this brood hatch in from five to eight, generally seven, days. The chrysalis hangs from seven to eleven days, and the butterflies of the third brood may be found during September, rarely or occasionally at the extreme end of August. At this season also there is less difference in time between butterflies of the northern and southern localities. Eggs of this brood are laid throughout September and take from eight to fourteen days in hatching; the earliest caterpillars, according to Mr. Edwards's observations, feed until partly grown, and after the second moult pass into hibernation; some kept by me fed until October 18, when they were put into a chamber with a temperature of 35-40° for the winter, and were found dead in the spring; the later-born caterpillars, as I have observed on several occasions, hibernate at once after devouring their eggshells, refusing all other food.

In all the essential features of the history then, the life of this butterfly is parallel to what we shall find in *B. bellona*, excepting that the time of apparition of the different broods is a little later than in *B. bellona* and no lethargy of the caterpillar has been certainly observed. The parallelism of the two cases is such that it can hardly be doubted that it exists but has not yet been detected. In some of the second brood I have once or twice seen what I thought to be signs of it, but accident prevented confirmation.

Habits, flight and postures. The butterfly frequents low, moist meadows and roadsides in their vicinity; it is fond of settling upon flowers and "especially on *Syngenesia*," says Mr. Gosse, adding, "it is numerous in the autumn on those flowers of the thistle which have not yet ripened, frisking to and fro, opening and shutting its tessellated wings to the sun" (*Can. nat.*, 290). Lintner mentions mint blossoms, and Jones white-weed as favorites. It flits lazily and aimlessly about, two or three feet above the ground, first making a few slight flutters, then sailing a short distance, and again resuming the motion of the wings.

When at rest, the wings are tightly closed, with all the costal edges continuous, the anal angle of the hind wing touching the surface of rest. The antennae curve a very little downward near the base, but beyond are nearly on a line with the plane of the body, drooping a little; viewed from above they are very slightly sinuous and diverge at an angle of about 100°. At more perfect rest, the antennae are bent outward near the base and are otherwise straight, diverging at an angle of about 135°, their tips being about 19 mm. apart. When walking, the antennae diverge only at right angles.

Desiderata. As the same questions are raised with this species and *B. bellona*, the student is referred to that species for desiderata.

LIST OF ILLUSTRATIONS.—BRENTHIS MYRINA.

General.		Chrysalis.	
Pl. 22, fig. 1.	Distribution in North America.	Pl. 84, fig. 12.	Side view.
Egg.		13.	Side view in outline.
Pl. 64, fig. 28.	Plain.	14.	Dorsal view in outline.
67: 18.	Micropyle.	Imago.	
Caterpillar.		Pl. 4, fig. 5.	Female, both surfaces.
Pl. 72, fig. 2.	Caterpillar at birth.	12: 4.	Both surfaces.
75: 2, 3.	Mature caterpillar.	33: 33-35.	Male abdominal appendages.
79: 7-9.	Front views of head, stages i, iii, v.	39: 7.	Neuration.
86: 81.	Dermal appendage, stage v.	61: 39.	Papilla of tongue.

BRENTHIS MONTINUS.—The dappled fritillary.

[The dappled fritillary (Scudder); red mountain butterfly (Maynard).]

- Argynnis montinus* Scudd., Bost. journ. nat. hist., vii: 626-30, pl. 14, fig. 1 (1863);
 —French, Butt. east. U. S., 163-164 (1886);
 —Mayn., Butt. N. E., 26, pl. 4, figs. 30, 30a (1886).
Brenthis montinus Scudd., Syst. rev. Am. butt., 25 (1872); Rep. geol. N. H., i: 354-55, pl. A, fig. 1 (1874).
Argynnis chariclea var. *b. montinus* Streck., Cat. Am. macrolep., 116 (1878).
 Figured by Glover, Ill. N. A. Lep., pl. 38, figs. 13, 15?, ined.

What more felicitie can fall to creature
 Then to enjoy delight with libertie,
 And to be Lord of all the workes of Nature,
 To raigne in th' aire from th' earth to highest skie,
 To feed on flowres and weeds of glorious feature,
 To take what ever thing doth please the eie?
 Who rests not pleased with such happines,
 Well worthy he to taste of wretchednes.

SPENSER.—*Mutopotmos*.

Imago (5: 14). Head covered with fulvo-olivaceous and yellowish hairs, the latter especially around the antennae and behind the eyes. Palpi beneath, externally, whitish buff from base to the tip; sides of the first and basal third of the middle segment white, beyond reddish fulvous, specked with black; on the inside pale flecked heavily with black; fringed heavily on the inner side beneath with long fulvous hairs and lightly on the lower portion of the sides with long black hairs; tip of palpi reddish fulvous, with a large admixture of black hairs. Antennae dull luteo-fulvous, heavily flecked with white beneath, over the whole surface of the basal ten or twelve joints; beyond that heavily at the base of each joint, narrowing to a point at the tip, the other parts being covered with the velvety black scales which occupy the whole of the upper surface excepting the base; the white scales infringe but little upon the base of the club, which is wholly velvety black, excepting the terminal three or four joints, which, above almost as much as below, are rather bright luteo-fulvous. Tongue luteous at base, blackish fuscous beyond.

Thorax covered with fulvo-olivaceous hairs, brightest on the prothorax and middle of the patagia; beneath fulvous, mingled, especially on the metathorax, with ochraceo-olivaceous hairs. Legs luteo-fulvous, the sides below marked with black, the tarsi a little infuscated, the fore legs covered with fulvous hairs and a few of a black color intermingled; femora of other legs the same, but beneath, like the under surface of the tibiae, enlivened with whitish scales. Spines luteo-fulvous, sometimes dusky; spurs luteous, sometimes fulvous at tip; claws dull luteous; pulvillus blackish fuscous.

Wings above deep orange fulvous, with black nervures and markings. Outer border of fore wings pretty regularly rounded; inner border straight. Basal half of the costal and inner borders, lower half of the cell and the medio-submedian inter-

space beneath it, heavily begrimed, especially next the base, with blackish scales and covered to some extent with long olivaceo-fulvous hairs; just within the middle is a slender, transverse streak which does not reach either nervure and is greatly obscured by the begriming of the base; just beyond the middle of the cell there is a broad, straight, transverse bar, which does not reach the median nervure and which sometimes contains a slender fulvous streak; between this and the extremity is a pretty broad, sinuate bar crossing the cell, and the extremity is marked by a similar straight bar; a V-shaped spot, its angle outward, crosses the medio-submedian interspace, its upper limb terminating at the first divarication of the median nervure. A rather narrow, interrupted, zigzag, mesial band consists of five straight dashes; the first starts from the upper subcostal nervule at three-fifths the distance from the base of the wing and crosses the subcostal interspaces in a direction at right angles to the upper subcostal nervule, and is sometimes connected with the costal nervure above by a small spot; the second crosses the subcosto-median interspace in the same direction but removed outward from the first by fully its own width; the third crosses the upper submedian interspace, still in the same direction, but removed inward from the second by double its own width; the fourth, with its inner border scarcely removed from the second divarication of the median nervure, crosses the lower median interspace at right angles to the nervures; the fifth crosses the medio-submedian interspace in the same direction, removed outward from the fourth by its own width. About one-third the distance between the upper part of the median stripe and the apex is a rather broad triangular dusky patch, depending from the costal border, extending just over the penultimate subcostal nervule; beyond the middle of the outer half of the wing, removed from the outer border by about double the width of an interspace, is a slightly sinuous series of six roundish spots, slightly truncate exteriorly, the lower three a little the larger, the lowermost slightly approaching the outer border; there is a submarginal row of triangular spots, their outer edges about three-quarters of an interspace from the margin, enclosing between themselves and the black-bordered outer margin, a series of transverse, sometimes continuous, fulvous streaks, larger and more conspicuous below than above; fringe mingled yellowish white and fulvous, interrupted broadly, sometimes very broadly, with blackish at the nervure tips. Costal margin of *hind wings* very slightly concave in the middle; outer border well rounded, more uniformly curved than in the other species; inner margin more broadly expanded near the base than in the other species, a little excised before the extremity. The basal half of the wing, as far as the mesial stripe (excepting the base of the subcostal interspace, and the extremity of the cell) and, in the medio-submedian region, even to the outer border of the wing, more or less heavily begrimed with dusky scales, partially concealing some of the markings; the inner border is very broadly and heavily covered with long, olivaceous hairs; extremity of the cell narrowly edged with black; just within it a narrow, transverse, curving, black stripe crosses the cell, meeting the terminal stripe above; not far from the middle of the cell is another similar stripe, almost entirely concealed in the griminess of the surface. A partially interrupted, very irregular, rather narrow, mesial stripe, composed of curving bars, crosses the wing; the subcostal interspaces are crossed a little beyond the middle of the basal half by a common, curving bar, opening outward; the subcosto-median by a lunule, curving in the opposite direction, at about two-fifths the distance from the extremity of the cell to the outer margin; the upper median by an oblique, sometimes sinuous bar, running at right angles to the part of the nervule on which it rests above, its exterior border on a line with the interior border of the previous lunule; the lower median by a straight bar, at right angles to the nervules, starting midway between the extremity of the previous bar and the second divarication of the median nervure; from here it seems to be continued in a nearly straight line to the submedian or even the internal nervure, but is greatly obscured by the begriming of the wing. In the middle of the outer half of the wing is an arcuate series of six rather large, round, black spots; the outer border is rather narrowly edged with black, there is a submarginal series of triangular spots, the extreme edges sometimes a little concave and

separated from the outer margin by half the width of an interspace, enclosing between themselves and the black margin a transverse series of sometimes continuous, fulvous, fusiform dashes; fringe as on the fore wings, but with less defined interruptions.

Beneath: *Fore wings* pale fulvous, the black markings of the basal half of the wing, together with most of the round spots in the outer half, repeated beneath more narrowly and vaguely, edged very narrowly and very faintly with fulvous scales, deeper in tint than the general tone; extreme base, especially along the median nervure, begrimed with dusky scales; costal edge, nearly to the tip, gray with a mingling of ochraceous and blackish scales; apex of the wing, half way to the extremity of the cell, and the whole outer border, cinnamoneous, enlivened with powdery patches of ochraceous, principally arranged in two transverse, oblique streaks, directed downward and somewhat inward from the costal border; at the tip of each interspace a straight, slender, longitudinal, median, ochraceous streak, as long as the width, terminated by a broad, sagittate, sometimes obsolete, blackish or cinnamoneous spot; fringe as on the upper surface. *Hind wings* deep cinnamon red; a silvery white spot near the base of the costal border at the tip of the precostal; near, but not quite at the junction of the principal veins, a rather small, silvery white spot, the lower one sometimes pretty large and round, and, like the one above it, edged with black exteriorly; in the middle of the cell a small, black spot, faintly edged with white; beyond this a broad premesial, bent, slightly curved band, made conspicuous principally by the irregular, broken, bordering, black lines; the interior border starts from the costal nervure and crossing the costo-subcostal interspace at an angle of forty-five degrees to the subcostal nervure strikes the latter a little within its first bifurcation; it starts again within the cell at the same bifurcation, and following, in a general way, the exterior limits of the cell, sweeps around to the first bifurcation of the median nervure, crossing which it reaches the inner border with a succession of sweeps having a general direction at about right angles to the nervules; the exterior border is composed of three parts; the first crosses the costo-subcostal interspace in a direction nearly parallel to the corresponding part of the interior border, but turned inward a little more than it, so that, if continued, it would strike the last bifurcation of the subcostal nervure; the second part, starting on the upper subcostal nervule at about a third the distance from its origin to the outer border, traverses the subcostal interspaces with a curve, usually shallow, opening outward in a direction generally at right angles to the nervules; the third part, originating on the lower subcostal nervule at a point as far removed from the second part as that is from the first, has a general direction parallel to the first part of the line, and passes by a series of irregular broken lines, or shallow curves—the subcosto-median opening inward, the others outward—to the inner border, a short distance before the tip of the internal nervure; the band itself is mostly cinnamoneous, nearly or quite as deep as the rest of the wing, but the black borders are narrowly edged, within the band with ochraceous, and a few ochraceous scales are scattered about, forming, in the part of the band contained in the subcosto-median interspace (excepting in immediate proximity to the median nervure beyond its last divarication) and in the costo-subcostal interspace (excepting next the costal nervure) large patches of ochraceous, which, next the interior border of the band, pass into silvery white; in the subcosto-median interspace, the limit of the two colors is marked by the extremity of the cell, which is narrowly edged with black or sometimes cinnamoneous; there is a submarginal row of transverse, lozenge shaped, silvery white spots, sometimes barely edged within with black, often partially obsolete near the middle of the wings, always larger toward the costal border; these are surmounted by large, tall, cinnamoneous spots, bordered with ochraceous scales, but faintly, excepting in the upper median and adjoining half of the subcosto-median interspaces; upon these are seated a faint, curving row of narrow circlets of ochraceous scales, parallel to the outer border, and enclosing rather small, cinnamoneous spots, inclining to black, deepest in color in the median interspaces; about midway between this series and the outer border of the intra-mesial band, and subparallel to

the former, is a narrow, rather faint and ill-defined band of rosy white scales, largest, and inclining to silvery white above, barely seen to be formed of lunules opening outward; fringe as on upper surface.

Abdomen blackish brown above, covered with long, fulvo-olivaceous hairs, becoming thicker and more fulvous toward the tip; the sides, especially toward the tip, besprinkled with fulvous scales; beneath dull ochraceous buff, mingled, next the black of the sides, with a few fulvous scales. Upper organ of the male appendages (33:41,42) with the hook moderately curved, rather shorter than the centrum, very deeply and sharply bifid, the points aculiform. Clasps nearly twice as long again as broad, exclusive of the processes, tapering rapidly to the base of the lower one, which is slender, equal, apically incurved, depressed and nearly as long as the median width of the blade; upper process of similar length, straight, equal, exceedingly slender, delicately tumid apically.

Measurements in millimetres. Length of tongue, 7.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	20.5		21.		21.75	
antennae.....	10.75				10.75	
hind tibiae and tarsi	7.		7.5		7.2	
fore tibiae and tarsi	3.		3.2		3.	

Described from 2 ♂, 1 ♀.

Secondary sexual distinctions. A slight difference in the neururation of the hind wing is found here as in other species of the genus, for which see the generic description.

Egg (64:38). About twenty-five vertical ribs, of which the greatest number reach the summit, the others uniting with those beside them, mostly above the middle of the egg, which is less flask-shaped than in the other New England species; interspaces between broken by cross lines about .04 mm. apart. Micropyle rosette (67:16) .15 mm. in diameter, composed of roundish, angular cells, increasing in size from the central cell, which is .0085 mm. in diameter, outward, those next the centre being about .017 mm. in diameter, and the outer .035 mm. Color of egg pale yellow. Height, 1.15 mm.; breadth about .8 mm.

Comparisons. This species is certainly distinguishable from *B. chariclea* (Schneid.) or *B. chariclea boisduvalii* (Somm.), both of which forms have been found by Mr. Couper on the northern shore of the Bay of St. Lawrence. Whether it should be looked upon merely as a geographical race, or as a species, is a question about which there may be easy difference; that it can be separated in some form admits of no doubt, and is the really interesting point. It is most closely allied to *B. chariclea boisduvalii*, but differs from it in the following particulars: The upper surface of the wings is deeper in tint, the base of both more extensively, though not more deeply begrimed; beneath, both wings are deeper in tint and the markings of the latter differ somewhat, the broad, intra-mesial band being, in *B. c. boisduvalii*, more generally suffused with ochraceous scales, making it, as a whole, more strongly contrasted with the rest of the wing; beyond the band the rosaceous scales are, in the same variety, more generally distributed over the whole space intervening between the band and the series of round spots, giving the whole a suffused lilac blush, while in the present species they are confined to a trans-

verse, better limited, though still vague stripe; the round spots are deeper in tint in *B. c. boisduvalii*, and the large, submarginal, triangular spots are of almost as deep a hue as in the present species, and edged more conspicuously with ochraceous than here.

From the typical *B. chariclea* it is more readily distinguished, the most striking differences occurring on the under surface of the hind wings. In *B. chariclea* the outer limit of the lower half of the intra-mesial band is deeply and largely serrate, the costo-subcostal and subcosto-median spots of the band wholly silvery white; the rosaceous band is more distinct than in *B. montinus*, though as limited as there, but it has become silvery white, and is reached by the serrations of the intra-mesial band; the round spots beyond it are small, without edging, and the submarginal triangular spots are also very small and almost black; the black spot in the cell also is reduced almost to a dot.

I have seen *B. chariclea* from southern and eastern Labrador; *B. c. boisduvalii* from Rupert's Fort, east coast of Hudson's Bay, and from Great Slave Lake.

Distribution. As far as known this butterfly is confined to the sub-alpine zone of the White Mountains (Shurtleff, Sanborn, Whitney, Scudder) and to the summits of surrounding mountains; it has been seen by Dr. Minot on the top of Black Mountain in Thornton, N. H.; several specimens were seen or captured by Mr. Faxon on Mt. Clinton, one of the White Mountain chain lying southwest of Mt. Pleasant.

Haunts. Probably no wandering collector has often seen more than eight or ten of these butterflies in a day's scramble among the mountains, but if sought early in July they might be found in greater abundance; on a single occasion only I have seen as many as four at one time; they are most common about the steep heads of the great ravines which have eaten their way into the heart of the mountain, and in the alpine gardens; they fly with no great rapidity close to the ground among the scanty foliage growing in the rocky crevices of the steep mountain sides; Messrs. Sanborn and Whitney have often seen them on mountain willow, *Salix herbacea* Linn., which grows but a few inches above the ground; so frequent and prolonged were their visitations to this plant that these observers sought carefully but in vain for eggs; and it is more probable that the caterpillar feeds upon some of the *Violaceae*.

Oviposition. I have also watched them narrowly, but have been unable to see them oviposit. On a single occasion a female, acting quite as if in search of a spot on which to deposit her eggs, alighted on a plant of *Geum radiatum* var. *peckii* and I was so sure she had laid upon it that I first netted the female and then examined the plant, only to find myself mistaken. A female with ripe eggs in her abdomen, as autopsy afterwards proved, was kept for an entire day in mid August, on a growing violet plant at an open

window in the hotel on the top of the mountain, and was then left, still on the plant, with others in similar condition, at the timber line for two more days; while still others were carried to the base of the mountain and kept on violet for a similar length of time; they were all fed with molasses and water, but were all moribund at the end of the two days and none laid any eggs whatever. As this was the fifth time I had gone to the White Mountains to obtain some clew to the early stages of this insect I was not a little disappointed. For a comparatively easy place to reach, where one, with patience, will be pretty sure to find this butterfly, I would recommend the extreme head of Huntington's Ravine, descending into it from above just far enough to be out of sight of the mountain summit.

Life history. Not much can be added to what has already been published concerning the seasons of this insect. The butterflies, never very abundant, have been found at various periods from the middle of July to the middle of September, and comparing their appearance and condition at these times with those of their allies in the valleys below the high regions which this butterfly inhabits, it seems highly probable that notwithstanding the bleakness of its chosen home, the history of this butterfly may be found to agree better with that of its neighbors on the plains below than with that of its European colleagues, which have one generation less a year; that is to say, the condition in which the butterfly is found leads one to conjecture that there are at least two broods even of this alpine butterfly. The first specimens that have been noted were taken July 12. Others were found on the 21st and at various times throughout August. Those captured on the 2nd of August had well developed eggs, others taken on the 11th of that month were noted as in "good condition." On the 14th I last year saw two or three dozen in tolerably fresh condition more broken than rubbed; of the fourteen taken four were females full of eggs quite developed, but the females could not be made to lay when enclosed on growing violets, as already noted; in a previous year I captured on the 15th of September, after a search of several hours, a single worn female with fifteen eggs in her body. She died the same night without laying on the violet on which she was placed shortly after noon. Now, inasmuch as a spring brood has been observed in Europe and America, in all the butterflies of this genus wherever any observations have been noted, and as butterflies of the present species with developed eggs have been found from the middle of August to the middle of September, requiring that this insect should hibernate in the caterpillar stage, it would appear probable that here, too, there is a spring brood of butterflies. Possibly those observed in July were only the later individuals of this first brood and that the second brood makes its appearance early in August. That the females of this brood may deposit their eggs at once upon eclosion is proven by the observations from the 2d to the 14th of August; but that

they may also retain them until the very end of the season is also shown by the observations on the 15th of September. All we can be sure of is that there is a late brood during August which continues into the middle of September; previous to that, owing to the bleakness of the situation, there is probably not more than a single brood, the later individuals of which encroach closely upon the earlier individuals of the second brood; though it remains to be inquired whether the later brood may not be made up of caterpillars which have shown their tendency to lethargy by a prolonged instead of a premature hibernation.

It should be added that in Europe, among the mountain species of this genus, only a single brood has been observed, and that this is found in some in June, or what would correspond to the presumed first brood of the present species; in others in the latter part of July and early in August, or what corresponds to the known brood of our mountain species. The European *B. thore* which flies in June is conjectured by Meyer-Dür to fly only in alternate years.

Attitudes. When sunning itself on the ground, as it is fond of doing, quite as much as of visiting flowers, it rests, as it does on the flowers, with fully or almost fully expanded wings, the costal edges of the opposite front wings nearly in a line, while the antennae, which are nearly straight but slightly arched and with the clubs bent slightly backward laterally, are raised at an angle of 45° with the body and divaricate about 135° . It moves about, whether on the ground or a flower, with similarly expanded wings. When at complete rest, the wings are closed, and the costal margin of the hind wing is parallel to that of the fore wing and separated from it by a space equal to the distance between the costal and subcostal veins; the antennae are now straight, raised at an angle of about 55° with the body, and divaricate about 90° . If disturbed in this position, the creature contracts itself still more, as it were, by dropping the fore wings so that the costal margin is as far behind that of the hind wings as they were before in front of it. At night, hanging vertically from a horizontal surface, the wings drooped together, the costal edges of all the wings adjoining; the abdomen also hung freely from the thorax between the wings, out of sight; the antennae, however, spread from each other at an angle of 80° , in a plane parallel to and just in advance of the costal edges of the wings.

Experiments. I experimented with this butterfly, as with *Oeneis semi-dea* and *Polygonia faunus*, already noted, and could not discover any difference in behavior between those taken to the summit, 6300', to Jacob's Ladder, 4500', or to the base, 2800'. It should be remarked, however, that the experiment was not tried under quite the same circumstances, as the descent was made deliberately, on foot by the old deserted Fabian Path, and occupied three hours.

Desiderata. Plainly the complete life history of this butterfly is a most

important need, and the few entomologists who visit the White Mountains should take pains to obtain it. The first thing is to secure the eggs of the female, and if she can be seen to deposit them, so much the better. Whatever the natural food of the caterpillar may be, it can doubtless be raised on violets and probably in well selected places at lower levels about as easily as above, where no one spends more than a few days at a time. But a few weeks spent in one of the Appalachian camps would yield the desired information on the spot itself. Visitors to the mountains in June should take particular note if this butterfly is seen; indeed its history at that time is most problematical. The question of lethargy in the caterpillar would be here a particularly desirable subject of study, as it would seem as if some special devices were needed to maintain this apparently nearly extinct species in such a desolate region, and all the points at issue in the other species may here find solution. Finally search should be made for butterflies of this type all the way from the White Mountains to the mouth of the St. Lawrence, to determine the relationship of this species with its nearest congeners in that district. Is there somewhere no line of demarcation between the two?

LIST OF ILLUSTRATIONS.—*BRENTHIS MONTINUS*.

Egg.

Pl. 64, fig. 38. Plain.
67:16. Micropyle.

Imago.

Pl. 5, fig. 14. Male, both surfaces.
33:41, 42. Male abdominal appendages.

BRENTHIS BELLONA.—The meadow fritillary.

[*Bellona* butterfly (Harris); meadow fritillary (Scudder); meadow butterfly (Maynard); the brimstone butterfly (Ross).]

Papilio bellona Fabr., Syst. ent., 517-518 (1775).

Argynnis bellona God., Encycl. méth., ix: 253, 171 (1819);—Boisd.-LeC., Léop. Am. sept. 164-165, pl. 45, figs. 5-6 (1833);—Geyer, Zutr. exot. schmett., v: 42, fig. 975, 976 (1837);—Harr., Ins. inj. veg., 3d ed., 287, figs. 113, 114 (1862);—Morr., Syn. Lep. N. Amer., 45-46 (1862);—Middl., Rep. ins. Ill., x: 83 (1881);—Coq., ibid., 183 (1881);—Fern., Butt. Me., 43-44 (1884);—French, Butt. east. U. S., 164-165 (1886);—Mayn., Butt. N. E., 26-27, pl. 4, figs. 31, 31a (1886);—H. Edw., Ent. amer., iii: 162-163 (1887).

Brenthis bellona Herr.-Schaeff., Corresp. zool. min. ver. Regensb., xix: 91 (1865);—Scudd., Am. nat., vi: 513-518 (1872);—Butt., 143-150, figs. 129, 130 (1881);—Scudd.-Speyer, Verh. zool. bot. gesellsch. Wien, xxiii: 145-152 (1873).

Papilio myrina Mart., Psyche, tab. 1, nos. 2, 3 (1797).

Figured by Glover, Ill. N. A., Lep., pl. 30, fig. 3, ined.

[Not *Papilio myrina* Cram.]

I behold the firefly's lamp
Waving in the thicket damp;
Evening-primrose sudden bloom
Mid the scented, sultry gloom;
Flitting moths, with ruby eyes;
Folded bees and butterflies.

EDITH M. THOMAS.—August.

Imago (5:13, 15:12:6). Head covered with deep fulvous hairs, tinged sometimes, especially in front, with yellowish green. Palpi outside white at base, changing

gradually toward the apex, first to yellowish buff, and finally to deep orange fulvous, all excepting the white portions besprinkled with black scales; fringed beneath with hairs which at the base are whitish, tipped with brownish yellow, then brownish yellow, and gradually changing toward the apex to fulvous; above bright fulvous, mixed with yellowish and besprinkled with black; within mostly greenish yellow, specked with black; a very open, sparse fringe of long black hairs, directed downward and outward, lies along the lower outer border and is best seen from an end view; a few black hairs are also intermingled in the fulvous tip. Antennae fulvo-luteous, above a little fuscous, besprinkled pretty heavily with white scales beneath on the basal fourth, outside along the whole stalk, and above, especially on the inside, at the base of each joint; club blackish brown, the apical three or four joints more or less brightly tinged with luteo-fulvous; the sides of the basal joints somewhat besprinkled beneath with white scales. Tongue fulvo-luteous, dull luteous along the median line near the base; beyond more or less fuscous exteriorly.

Thorax covered above with black scales, concealed by fulvous hairs, more or less tinged with greenish, beneath with orange fulvous scales and dark fulvous hairs; fore legs concealed by dark fulvous hairs; other legs luteous, the femora specked slightly on the sides and beneath with black, above with white scales; spurs, spines and claws luteous.

Wings above pretty uniform pale fulvous, the hind wings scarcely paler, heavily marked with black, having a slight purplish reflection. Outer border of *fore wings* scarcely rounded, but very slightly angulated at the middle of the subcosto-median interspace, the angle broadly rounded; the border above the angulation nearly straight, perhaps scarcely convex, below it scarcely concave; inner border straight or with scarcely perceptible concavity. Nervures lightly marked with blackish; wing lightly begrimed at the base, nearly half way to the extremity of the cell, and along the costal edge to the extremity of the cell, by a mixture of fulvous and black scales; the cell is crossed in the middle by a heavy, slightly diagonal, irregularly O-shaped or open pyriform spot, largest beneath; nearly midway between it and the base the cell is crossed by a small roundish spot, and midway between it and the tip by a sinuate bar having a general direction parallel to the exterior border of the cell; the latter is bordered within and without with black, itself more or less distinctly fulvous. A very irregular, sinuate, continuous, pretty broad mesial band starts from the costal border at quarter the distance from the extremity of the cell to the tip of the wing, and crosses the subcostal interspaces in a direction generally parallel to the exterior border of the cell; the subcosto-median interspace is crossed by a broad, roundish lunule curving outward, whose interior border is nearly continuous with the exterior border of the previous part of the stripe, and whose limbs unite it slenderly with the adjacent parts of the same; the median interspaces are traversed close to the base by heavy lunules, curving inward, leaving at the very base, between them and the nervures, small, triangular, fulvous spots; the medio-submedian interspace is crossed at about two-fifths the distance from the first divarication of the median nervure to the outer border by a broad, irregular bar, parallel to the outer border, and the next by a heavy diagonal streak stretching inward, sometimes nearly half way to the base of the wing. Within the mesial stripe, just below the first divarication of the median nervure, the medio-submedian interspace is crossed by an irregular V-shaped stripe, the angle outward, sometimes extending to the mesial stripe, the upper limb often connecting with the bar crossing the middle of the outer half of the cell, the lower pushing along the submedian often half way to the base of the wing; in the same interspace, near the base, is a straight, longitudinal dash, sometimes obscured, sometimes joining the V; from the costal border, midway between the extremity of the cell and the tip of the wing, depends an obscure fuscous, slender, elongated patch, crossing the whole or only a portion of the subcostal interspaces, nearly at right angles to the costal border; beyond this is a broken series of six roundish spots, parallel to the outer border and distant from it by twice the width of the interspaces; the upper three are smaller, and occupy the two lower subcostal and the subcosto-median interspaces;

the three lower, occupying the succeeding interspaces, are half as broad as the interspaces, twice as large as the preceding, and have their exterior border on a line with the interior border of the upper ones; there is a broad, double, marginal line, often obscure, and the outer partially obsolete, the outer formed of transversely oblong-ovate patches, whose centre is on the nervules (which at this point are often bordered heavily on the outer side), the inner of similar but generally broader and more distinct patches, whose centre is in the middle of the interspaces; the upper two are larger, forming a moderately large, apical, longitudinal patch; outer border edged with black; fringe pale fulvous or whitish, interrupted broadly and vaguely at the nervure tips with blackish fuscous. Costal border of *hind wings* straight or very nearly so; outer border rather broadly rounded, more so than in the other species; inner margin scarcely convex beyond the basal expansion. The basal third of the wing rather heavily begrimed with black scales, especially below the median; the veins, as far as the mesial stripe, distinctly but narrowly marked with black; the irregular exterior border of the cell, itself distinctly fulvous, is narrowly bordered on either side with black; the cell itself is crossed, just before the middle by a roundish spot, and beyond by a sinuate bar, sometimes partially merged in the extreme border; a rather narrow mesial stripe crosses the wing irregularly, formed in a general way of two limbs bent, in the centre of the wing, at right angles; the upper half, composed of broad lunules curving outward, having a general direction from the middle of the costal border to the tip of the middle median nervule; the lower half composed of diagonal bars (the interior border of the upper half of this limb on a line with the exterior border of the lower half) whose general direction is from the tip of the upper subcostal nervule to the middle of the inner border; it terminates at the internal nervure; a little less than midway between the mesial stripe and the outer border is a continuous arcuate series of six round spots, nearly equal in size, parallel to the outer border and in the same interspaces as those of the fore wings; there is a submarginal series of minute spots on the nervures, beyond which the nervules are edged with black, forming thus little T-shaped spots seated on the margin; just above there is a row of larger transverse patches in the interspaces, similar to that of the fore wings; the border itself is delicately edged with black; and the fringe is pale fulvous or whitish, with a few intermingled fuscous scales, especially near the nervure tips.

Beneath. *Fore wings* pale yellow fulvous, the black markings of the base of the upper surface, as far as and including the mesial stripe, repeated narrowly beneath, the mesial stripe broken into detached spots; the extra-mesial row of round spots is also repeated beneath, the upper one obsolete; the apex of the wing, succeeding the interior border of the subapical triangular patch of the upper surface, and excepting a large, roundish, dull yellow spot crossing three interspaces at the very tip, cinnamonaceous, enlivened above the black spots with a few dull pearly scales; between the reddish apex and the black mesial band, the wing is dull yellow, and a great many dull yellow scales, sometimes forming small patches, break up the broad, cinnamonaceous, outer border; there is sometimes a submarginal row of darker red sagittate spots in the interspaces, deepened by a few black scales and marking the interior limit of the outer cinnamonaceous border; costal border enlivened by a sprinkling of dull, pearly scales; fringe similar to that of the upper surface, but dark brown in place of black. *Hind wings* with a broad, irregular, intra-mesial band of pale, obscure fulvous, more or less besprinkled with cinnamonaceous, but made distinct by its narrow edging of cinnamonaceous being often deepened by blackish brown; the interior border crosses first the costo-subcostal interspace by a bent line, midway between the divarication of the costal and subcostal nervures and the first divarication of the subcostal nervure, is then parted and starts afresh from the first divarication of the subcostal nervure and, following this nervure to its next divarication, crosses the cell to a little beyond the first divarication of the median nervure, is again broken, crosses the medio-submedian interspace in a zigzag course, just within the first divarication of the median nervure, and the succeeding interspace a little further down, and terminates a little beyond the middle of the internal nervure; the exterior border starts

from the costal nervure, just beyond the middle of the costal border and crosses the first interspace by a line bent in an opposite way to that of the interior border, crosses the subcostal interspaces in the middle of their basal half by a sinuous line, the subcosto-median interspace at its narrowest part (two-fifths the distance from the extremity of the cell to the border) each of the median interspaces close to the base—all by curved lines; the middle of the medio-submedian interspace by a zigzag line the reverse of that of the interior border; and the submedio-internal by a curved line, terminating on the internal nervure close to its tip. The whole costal edge and sometimes the extreme base of the costo-subcostal interspaces, and the portion of the intra-mesial band which is contained in the same interspace, covered with hoary, iridescent scales; within the intra-mesial band, the wing is cinnamoneous red, sometimes partially enlivened with fulvous, the cell with a central, blackish spot, sometimes with a fulvous pupil and a basal, curving, black line, sometimes crossing the adjacent interspaces; just beyond the intra-mesial band, the wing is cinnamoneous; beyond its extreme limit in the middle of the wing it is much beclouded with a lilac flush, caused by rosaceous scales, and ornamented by a series of six, transverse, oval or roundish, faint, greenish opalescent spots, edged with cinnamoneous (sometimes almost entirely cinnamoneous), subparallel to the outer border and separated from it by twice the width of an interspace; distant from the outer border by nearly the width of an interspace, is a submarginal series of pretty large, sublunate, cinnamoneous spots, followed by a row of similar but smaller and fainter fuscous spots; outer border narrowly edged with black, the fringe dull fulvous, sometimes whitish, with some fuscous scales at the nervule tips.

Abdomen above brownish, enlivened with fulvous hairs above and scales at the sides, especially at the tips of the segments; beneath dark fulvous, the tips of the segments with more or less yellowish. Upper organ of male (33: 38, 39): hook strongly curved, of about the length of the centrum; tapering as in *myrina* but more delicately bifid than there. Clasps fully twice as long as broad, exclusive of the processes; tapering gently throughout, it terminates in a slender process obliquely depressed, longer than broad, a little incurved, the extremity rounded and scarcely denticulate, bearing at its innermost limit a slightly curved needle, directed forward and a little inward; upper process longer than this lobe, very slender and cylindrical but depressed and spatulate at the tip.

Measurements in millimetres. Length of tongue, 7.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	22.5		23.	19.	21.	24.5
antennae.....	10.5			9.15	10.	
hind tibiae and tarsi..	7.2		7.5	6.5	6.75	7.5
fore tibiae and tarsi..	2.25			2.25	2.25	3.

Described from 2♂, 6♀.

Melanic form. Mr. Walter Faxon captured a male in July and I have reared a female in September, in both of which the middle of the upper surface of the fore wings, included between the outer border and the mesial stripe, the inner border of the bar in the middle of the outer half of the cell, and the V-shaped stripe in the medio-submedian interspace (together with a corresponding space on the hind wings) are almost wholly and uniformly black, relieved only by slight fulvous spots or streaks near the apex of the cell. The markings upon the under surface of the fore wings are broader than usual, but not suffused as above; in no other respect did these individuals differ from the normal type.

Secondary sexual distinctions. See the description of the genus for a slight distinction in the neuration of the hind wing.

Egg (64: 27). Twenty-one or twenty-two longitudinal ribs, a transverse section of which is wedge shaped, elevated, of equal prominence throughout, but somewhat irregular in direction and in distance apart, averaging in the latter particular .1 mm.; eight or nine of them reach the summit, the others extend only to the middle or upper

half of the sides and are there connected with those beside them by transverse ridges, or are abruptly united with a neighbor to form a single rib; space between them divided by delicate, but rather prominent, raised lines .047 mm. apart, forming oblong cells, the floors of which are covered with minute, circular and oval, shallow punctulations, occupying less than half of the surface, the largest of them .0042 mm. in longer diameter. Micropyle rosette (67:17) .068 mm. in diameter, nearly circular, composed of a number of lenticules, increasing slightly in size from the centre outward, laid regularly over one another like roofing tiles, the largest .015 mm. in diameter. Color of egg pale yellowish, changing afterward to pale fuscous, and just before hatching to dirty yellowish below, fuscous above. Height, .96 mm.; greatest breadth, .6 mm.; breadth at summit, .22 mm.

Caterpillar. *First stage.* Head shining piceous or blackish castaneous toward the mouth parts, the latter tinged with olivaceous; ocelli black. Body pale dusky green, banded where the warts occur with obscure ferruginous; bristles blackish; legs and prolegs pale green. Length, 2.25 mm.; breadth of body, .46 mm.; length of hairs on body, .34 mm.

It differs from the same stage of *B. myrina* in having the spicules of the hairs much stouter and more conspicuous, and the expanded apex slightly larger.

Second stage. Head shining piceous, covered with a few, pale, straight hairs, of variable length; antennae pale, marked with fuscous; labrum pale; mandibles blackish. Body dark purplish olivaceous marked with obscure dull, pale greenish streaks, forming a dorsal V on each segment, a broken lateral line and an infrastigmatal one; tubercles black, with numerous, pretty long, straight, lateral needles and a slightly longer one at tip. Length, 5 mm.; breadth, 1 mm.

Third stage. Head (79:10) smooth, shining, dark metallic green, covered with a few scattered blackish hairs of variable length. Body purplish black, on the sides dotted and most delicately streaked with very pale purplish; at the outer base of each laterodorsal tubercle is a pale yellowish white, longitudinal streak, forming a broken lateral line; tubercles shining metallic purplish black, bountifully beset with straight black thorns; tubercles of the first thoracic segment barely if any longer than the others. Spiracles black, set in a pale purplish spot; legs black. Length, 13 mm.; breadth of body, 2.5 mm.; of head, 1.2 mm.; length of spines, .5 mm. It differs but little from the previous stage.

Fourth and fifth stages. (75:1, 5; 79:11). Differs again but slightly from the third stage, excepting in the tubercles, and in the presence of a lateral broken, velvety black band. The tubercles have become pale, dull luteous, the apical half or third blackish fuscous, and the needles fuscous; those of the thoracic joints are slightly longer than the abdominal ones, especially the anterior pair in the laterodorsal row, although even here the difference scarcely admits of measurement. Length when full grown, 21 mm.; breadth of body, 3.25 mm.; of head 2.1 mm.; length of spines, 1 mm.

Chrysalis (84:10.11). Dark yellowish brown, made up of fuscous brown streaks on a yellowish brown ground. Ocellar prominences separated by a wider space than in *myrina*, marked above with brownish fuscous; front of head tinged with very, pale blue; wings tinged with a cupreo-olivaceous hue, having a blackish mesial dash, and some of the veins narrowly marked with black; hinder edge of wings at base, and basal wing tubercles blackish fuscous; on the abdomen a slender, obscure, blackish line passes through the spiracles, followed beneath by a broad, obscure, silvery white band; an equally broad ventral band, conspicuous only by its blackish outer borders; between it and the substigmatal band are two equal bands, the upper similar to the ventral band, the lower, an obscure white band; laterodorsal tubercles constricted beyond the middle, the apical portion nearly equal, bluntly rounded at tip; those of the first abdominal segment of the same size as those on the adjoining segments; those of the thoracic and first and second abdominal segments mercurial, tipped with yellowish brown; the others reddish brown, each of those on the fifth to the seventh segments connected with its mate by a bent A-shaped dusky band, edged posteriorly with pale, the apex reaching the middle of the anterior edge of the segment; dorsal

tubercles pale; spiracles yellowish brown with fuscous lips; cremaster reddish brown obscured with fuscous. Length, 14 mm.; width at ocellar prominences, 2.6 mm.; at thorax, 4.5 mm.; at third abdominal segment, 4.4 mm.; height at thorax, 3.5 mm.; at third abdominal segment, 5.5 mm.

Geographical distribution (22:2). This butterfly occupies nearly the same territory as *B. myrina*, and though not known from so far north seems more abundant in northern localities than its congener. Like that species it has been reported by Boisduval and Lucas from Cuba; indeed Boisduval expressly says he has seen specimens from there, and Geyer also gives this island as its home, but Gundlach has not discovered it and analogy and its distribution in the United States render its presence there altogether improbable; nor do I know any Cuban insect which could have been mistaken for it. The southernmost localities from which it is otherwise reported are Staten Island (Davis), New Jersey (Andrews), Philadelphia "common" (Blake), Rockport (Kirtland) and Cleveland, Ohio "common" (Kirkpatrick) and northern Illinois (Worthington); it is one of the commonest species in Wisconsin (Hoy). It does not seem to be found so far east as Nova Scotia or New Brunswick, but westward it extends to Iowa "not uncommon" (Osborn, Parker), Chippewa (Brit. Mus.), Moose Factory, Hudson Bay (Weir), Nepigon, Lake Superior (Fletcher), Lake Winnipeg (Scudder), Great Slave Lake (Edwards*), Fort Ellis (Geddes), Dufferin (Dawson), and the middle park of Colorado (Mead). Captain Geddes in travelling west on the Canadian Pacific railroad noticed it in large numbers at Brandon, a little more than a hundred miles west of Winnipeg, but found that it grew continually rarer west of that, and at Calgary near the Rocky Mountains was "quite rare." West of the Rocky Mountains it appears to be replaced by *B. epithore*, a closely allied form, extending to California and thought by some to be only a variety of this species. This enumeration also includes some of its most northern localities, to which may be added Martin's Falls, Hudson Bay (Brit. Mus.). It is also more or less common on the lower St. Lawrence, as far as the mouth of the Matapodan (Bell), and even to the Godbout River (Corneau), and occurs throughout most of the settled parts of Canada; it has been reported, for instance, at Quebec "rare" (Bowles, Fyles), Ottawa common (Fletcher), Arundel (D'Urban) and opposite Lachine in the Chateauguay basin (Jack), although it has not been found near by at Montreal (Caulfield, Pearson).

In New England it seems to be as well distributed and as common as *B. myrina*, although it is elsewhere considered somewhat less abundant. It must reach nearly or quite to New Brunswick, for it occurs on Mt.

* Edwards does not give this locality in recent lists, and perhaps now looks upon specimens formerly so determined as belonging to *B. epithore*.

Desert Island (Scudder) and appears to be common at Orono (Fernald), as elsewhere in Maine. I have taken it on the summit of Mt. Washington. In the White Mountains and about Boston it is equally common, and besides I have it reported, or have taken it myself, at Norway, Waterville, Brunswick and Hallowell, Me., Milford, Thornton, Dublin, Suncook and Plymouth, N. H., Stow, Vt., Walpole, Montague, Amherst, Springfield, Belchertown, Andover, Worcester, Princeton, and Williamstown, Mass., and Farmington and New Haven, Conn.

Haunts. This butterfly is more or less local in its haunts, being found only about wet meadows and bogs, where it frequents the mint blossoms, according to Mr. Lintner, flies with moderate rapidity, fluttering in a waving, zigzag course about two or three feet above the ground, and is easily captured.

Food-plant. The caterpillar appears to feed indiscriminately upon wild and cultivated Violaceae. Mr. Dimmock writes, "specimens which I bred fed upon either ordinary turf-grass or white clover, both of which I had in the box."

Habits of the caterpillar. At eclosion the caterpillar invariably gnaws its way through the upper side of the egg, afterward devouring either the whole or a portion of the deserted shell; its habits closely resemble, in fact cannot be distinguished from, those of its congener, *B. myrina*, including the phenomena of lethargy.

Life history. As mentioned under the genus *Brenthis*, I was formerly constrained to construct an hypothesis concerning the periods of this insect (*American naturalist*, vi: 513-518) which seems no longer tenable. I then supposed that instead of confining itself to the uniform cycle of changes common to most butterflies, this insect exhibited two sets of individuals, each with its own distinct alternations, so that in tracing the history each series would need to be treated as if it were a distinct species. Later research, however,—the observations of others as well as my own, extending over several years,—shows that the behavior of this insect, though striking enough, does not so essentially differ from that of ordinary butterflies.

It is a somewhat earlier butterfly than its congener *B. myrina*. The first brood of butterflies is heralded by a few individuals between the 4th and 15th of May, but it rarely becomes common before the end of May, although Mr. Lintner once found it not rare in Schoharie, N. Y., on the 13th. Occasionally it has escaped the notice of observers until toward the end of May, but this may be due to the observer's not visiting the proper haunts of the species previous to the date noted; and as in certain years its advent is likely to be somewhat retarded, he might easily suppose that the few individuals he saw in the latter half of May were the first that had appeared. But it appears as early as the middle of May in

such northern localities as Hallowell (Miss Wadsworth) and Orono, Me. (Fernald), and was noted at Norway in the same state (Smith) on the 18th. Fresh specimens continue to emerge from the chrysalis throughout the whole of June, and may still be found on the wing until August, for the butterfly is more than ordinarily long-lived. The eggs are never laid, so far as I have been able to discover, before the middle of June or more than a month after the first appearance of the butterflies. I have no memoranda of the duration of the egg stage of this brood, nor of the length of time it requires at this season of the year for the insect to attain maturity, nor as to whether any of the caterpillars when partly grown exhibit any lethargic tendency, as appears at a later period of life in this and in other species. The second brood of butterflies begins to emerge about the middle of July, sometimes as early as the 10th and 12th, even in such northern localities as Plymouth, N. H., and even occasionally as early as the 3d about Boston, the males a little earlier than the females and throughout the earlier part of the flight of this brood more abundant than the females. The eggs of this brood are sometimes fully matured in the female shortly after eclosion (though in other cases they are not), and accordingly may be laid as early as the middle of July in Boston latitudes, and during the last of July and early August farther to the north. The butterflies of the new brood become abundant toward the end of the month and like those of the earliest brood are long-lived, continuing on the wing until the early part of September, and lay their eggs throughout August. The eggs hatch in from five to nine days. The caterpillars ordinarily require about a month for full growth in the vicinity of Boston. Some raised in confinement at this season were 34 days from egg to chrysalis. The chrysalis hangs for seven days, and early in September or even in the last days of August, the third brood of butterflies makes its appearance. But a considerable number of the caterpillars of this second brood become lethargic when half grown, after the second or third moult, remain quiescent, curled up in out of the way places in leaves or under twigs, and in this state a portion of them continue throughout the winter and probably produce the earliest butterflies that are seen in the spring. Others, however, after remaining two or three weeks in this condition, revive again, and change into butterflies late in the same season toward the middle of September. The third brood of butterflies makes its appearance as stated, early in September, and the butterflies of this brood, as I have observed in recent years, are frequently ready to lay their eggs soon after birth, the earliest being laid during the last week in August or the first week in September (Mr. Edwards obtained eggs the 23d of August in the Catskills), while the latest butterflies from retarded caterpillars do not lay their eggs until toward the end of September. The eggs hatch in about eight days and the caterpillars born of these two series of butterflies, those

which have been produced directly without any interruption and those which came from the retarded caterpillars, seem to behave in a different way, the first feeding until they have passed two or three moults (or the lethargic period in this caterpillar), when they go into hibernation for the winter; while the caterpillars from the later eggs, laid by butterflies presumably from the retarded caterpillars, hibernate at once after leaving the egg; and this difference in age of the hibernating caterpillars no doubt accounts, at least in part, for the length of time during which in the spring fresh butterflies make their appearance.

It is a curious fact that in all the experiments of Mr. Edwards in the Catskills and in West Virginia, upon the allied species *B. myrina*, he has in no case observed any instance of lethargy on the part of caterpillars obtained by him. But as it has been observed in this species in the neighborhood of Boston, in caterpillars raised from the eggs obtained from Professor Hamlin about Waterville, Me., as well as in those from eggs obtained about Boston in several instances and in different years, there can be no doubt that such a phenomenon does sometimes occur, at least in the present species. In both the spring brood and the mid-summer brood of butterflies, there are many instances, as I have found by repeated examination covering many different years, in which the eggs are not developed in the body of the mother until the butterfly has to all appearance been upon the wing for several weeks, and even apparently for more than a month; and it would appear from the condition of those in which eggs were found (though of this there can be of course no absolute proof), that when the eggs are not developed at birth they do not develop in the body of the female until at or about the time of the appearance of the subsequent brood of butterflies, so that one finds upon the wing and laying eggs at the same time individuals of the first and second and of the second and third broods. My failure years ago to obtain eggs from fresh females in July and September, led me to believe that all the eggs laid at that time were laid by old decrepit females, and the hypothesis of two series of individuals was constructed partly on this basis. It has since been proven by my own observations, as well as by those of others, that the fresh individuals of the two later broods often lay eggs shortly after eclosion. But I have not yet been able so to obtain them from individuals of the first brood. It thus appears probable that a mixture of broods takes place in two distinct ways: first, by the commingling of fresh and worn egg-laying females upon the wing late in July and late in August, i. e., belonging to the first and second, and the second and third broods, and second by lethargy on the part of the caterpillars of one brood by which the butterflies produced from them apparently form a part of the brood which regularly succeeds them in time. It should be remarked also that, as observed by several of my correspondents, this butterfly is very much

more common on the wing in September than in July and August; and it has appeared also to me (though it has not been remarked to me by others) that the spring brood of butterflies is also more abundant than the mid-summer brood; this state of things would naturally be brought about by the reinforcement of numbers in the later brood, and the possible robbery of the second through lethargy on the part of the caterpillars, and the retention of the eggs in the ovaries by the butterflies. This account, coupled with the very different conclusions of Mr. Edwards, seems to show that we have yet much to learn concerning the actual history of this interesting butterfly.

Habits, etc. It delights to bask in the sunshine, slowly opening and closing its checquered wings, beating time, as it were, with its head, which is raised with the opening of its wings. The fore wings during this motion, or when the butterfly is at rest, are so far advanced as to leave between their inner margin and the costal border of the hind pair an opening which extends half-way to the base; the antennae diverge at right angles and are raised at an angle of about 65° .

In its most quiescent state, the wings are closely shut and the fore wings so hidden by the hind pair that the outer angle of the latter projects slightly beyond the costal margin of the former. Previous to assuming this position, the fore wings are more advanced, the outer angle of the hind wings just reaching the middle median nervule, the inner edge of the hind wings and the abdomen being parallel with the surface of rest and at an angle of 35° above the plane of the remainder of the body; the legs are broadly spread; and the antennae are held erect, at right angles with the front half of the body at their base, rising parallel and then diverging at an angle varying from 65° to 100° .

Enemies. As our knowledge of the early stages of this insect is exclusively based upon specimens raised from eggs laid in confinement, we are entirely ignorant of any parasites that may attack it. But Gentry states that the caterpillar is eaten by the meadowlark, *Sturnella magna*, and the imago of this or *B. myrina*, or both, by the rough winged swallow, *Stelgidopteryx serripennis*.

Desiderata. It will be seen by the foregoing account that there are many points in which further investigation is necessary to make the history of this butterfly complete. The extent of time over which the advent of butterflies fresh from the chrysalis is spread renders it more than usually difficult to decipher the history, and we need to know more certainly the cause of this range itself. How large a proportion of caterpillars in different localities hibernate as soon as born, and how many when half grown? How soon after eclosion do butterflies of the first brood lay eggs and what is the range in this respect in each of the broods? Is there any time-hiatus in egg-laying between the broods, and if so, is it bridged by different indi-

viduals of a single brood? Is any lethargic tendency seen in the caterpillars of the first brood, and to how great an extent is it found in those of the second? Is the comparative abundance of the different broods in any one place affected by lethargy of caterpillars, or abstinence in oviposition of butterflies? and if so, how and to what extent? It would be very interesting to compare the annual history of this butterfly in the northern and southern parts of its range. Is it anywhere double brooded, and if so, which brood is then the more abundant in individuals? Parasites of this butterfly are unknown, and the habits of the caterpillar have not been observed in free nature. Does it occur in New Brunswick and Nova Scotia? or in Wyoming and on the northern branch of the Saskatchewan, as we might be led to suppose from the known facts of its distribution?

LIST OF ILLUSTRATIONS.—*BRENTHIS BELLONA*.

<i>General.</i>		<i>Chrysalis.</i>	
Pl. 22, fig. 2.	Distribution in North America.	Pl. 84, figs. 10, 11.	Side views.
	<i>Egg.</i>		<i>Imago.</i>
Pl. 64, fig. 27.	Plain.	Pl. 5, fig. 13.	Male, both surfaces.
67:17.	Micropyle.	15.	Female, both surfaces.
	<i>Caterpillar.</i>	12:6.	Both surfaces.
Pl. 75, fig. 1.	Mature caterpillar.	33:38, 39.	Male abdominal appendages.
5.	Caterpillar nearly grown, dorsal view.	54:1.	Side view of head and appendages enlarged, with details of the structure of the legs.
79:10, 11.	Front views of head, stages iii, v.		

TRIBE MELITAEIDI.

CRESCENT-SPOTS OR GREGARIOUS FRITILLARIES.

Melitaeidae Newman.
Hamadryades Borkhausen.

Papiliones variegati Wiener Verzeichniss.

. . . O thou, to whom
Broad leaved fig trees even now foredoom
Their ripen'd fruitage; yellow girted bees
Their golden honeycombs; . . .
. . . pent up butterflies
Their freckled wings; yea, the fresh budding year
All its completions—be quickly near.

KEATS.—*Endymion*.

Imago. Head: club of antennae moderately long, well marked, three or four times as long as broad, with a single or no carina beneath. Palpus very long and slender, scarcely thickened by hairs or scales; terminal joint pretty long,—from one-half to one-third the length of the middle joint.

Thorax: first superior subcostal nervure of fore wings arising before the tip of the cell; the second at or a little beyond the tip; cell closed; median nervure connected beyond its second divarication with the vein closing the cell. Precostal nervure of hind wings originating beyond the divarication of the costal and subcostal nervures; cell open or partially closed. Tarsi destitute of spines above, and the tibiae nearly so; four rows of spines on the under side of the terminal tarsal joint; fore tarsi of female composed of five joints, with a few spines besides the spurs, the last joint unarmed.

Abdomen : appendages of male ; upper organ small and insignificant, destitute of a distinct hook ; clasps small and compact, generally more or less quadrate and rather gibbous at the base, bearing an apical, usually curving, finger-like hook, and an interior, more or less sickle-shaped spine, crossing that of the opposite side. In these organs the group recalls the Vanessidi rather than the Argynnidi.

Egg. Somewhat acorn-shaped, higher than broad, well rounded at base and at sides, and broadly docked at summit, with very slight and pretty numerous longitudinal ribs occupying only the upper half of the egg, while below the surface is smooth, or indented with polygonal or rounded depressions.

Caterpillar at birth. Papillae of the body inconspicuous, all arranged in paired rows, of which there are three on either side of the body above the spiracles, and which are disposed in nearly the same manner on the thoracic and abdominal segments ; slender, tapering, finely pointed, not very long, and sometimes faintly spiciferous hairs arise from the papillae.

Mature caterpillar. Head somewhat smaller than the body, but little, if at all, tumid above. Body attenuated a little anteriorly on the thoracic segments. Abdominal segments divided into a much larger anterior and a short posterior subsegment, the former sometimes indistinctly divided again posteriorly. Spines heavy and coarse, tapering, with diverging needles, mounted on wartlets, and directed angularly upward. Spines arranged in a mediodorsal row on the abdominal segments, and three additional rows on either side above the spiracles on most of the segments ; the first thoracic segment with a transverse row either of spines, the upper ones (at least) shorter than those of the rest of the body, or of long hairs.

Chrysalis. Head not projecting independently beyond the thorax, but forming, as it were, a single mass with it. Superior border of wings with a slight blunt elevation in the place of the secondary tubercle. Dorsum of the mesothorax pretty regularly rounded, scarcely carinate. Dorsum of abdomen not longitudinally carinate, but with a dorsal and laterodorsal series of equal, small, blunt tubercles ; cremaster with a lateral prominence near the base.

The butterflies of this tribe closely resemble the Argynnidi in structure, and have generally been considered more intimately associated with them than is here represented. They are either of the medium or somewhat under the medium size, and, like the previous tribe, are usually fulvous colored above, but so much more heavily bordered and chequered with black, that some genera are almost black with tawny spots ; beneath, the markings somewhat resemble those of the Argynnidi, but the hind wings are paler in tint, with seldom any trace of silvery or nacreous markings ; as in the Argynnidi, or to a greater extent, the wings are rounded and somewhat elongated. The insects are of rather feeble flight, and seldom rise far above the ground. They are generally abundant in individuals, and often very local in their distribution.

They are mainly characteristic of the New World, where they abound in the tropics and north temperate zone, but they are also well represented in all the northern parts of the Old World, and many species are found in the higher mountain regions of both hemispheres.

They are generally single brooded toward the northern limit of their range, or in high altitudes, but double brooded or polygoneutic elsewhere. The eggs are generally (perhaps always) laid in clusters, and the caterpillars, at least in the early half of their life, are social, often construct-

ing common webs,* in which some kinds hibernate; for, so far as known, all the species of this tribe, whether in the New World or the Old, pass the winter as half grown caterpillars.

The eggs approach those of the *Vanessidi* in form, but are very slightly ribbed, and that only on their upper half. The caterpillars feed on low plants, mostly *Scrophulariaceae* and *Compositae*; they are generally dark colored and resemble the caterpillars of the *Argynnnidi*, but instead of the long, often unequal, conical prominences, they are provided with rather low, equal, blunt, fleshy tubercles beset with needles; the head is never crowned with spines. The chrysalids are rounded, but covered with low, conical tubercles in longitudinal series, and have, occasionally, other slight angulations.

Table of the genera of Melitaeidi, based on the egg.

Egg with thimble-like depressions on the sides.	
Egg scarcely higher than broad; thimble-like depressions covering the lower half of the egg.....	Phyciodes.
Egg half as high again as broad; thimble-like depressions confined to the middle third of the egg.....	Charidryas.
Egg with surface smooth excepting for the vertical ribs.	
Egg about one-fifth higher than broad.....	Cinclidia.
Egg about one-third higher than broad.....	Euphydryas.

Table of the genera, based on the caterpillar at birth.

Hairs of body much longer than width of body.....	Phyciodes.
Hairs of body shorter than width of body.....	Euphydryas.
Charidryas and Cinclidia not examined.	

Table of the genera, based on the mature caterpillar.

Body cylindrical throughout, or scarcely tapering forward on the thoracic segments, marked with longitudinal stripes of a pale and dull color in contrast with a darker ground; constructs no web at any period of life.	
Tubercles of body stout, conical, less than twice as high as broad.....	Phyciodes.
Tubercles of body slender, tapering but little, fully three times as high as broad.....	Charidryas.
Body distinctly tapering forward on the thoracic segments, marked alternately and transversely with black and bright orange colors on most of the abdominal segments; lives in a web in early life.	
Body sprinkled between the tubercles with very short and exceedingly delicate, scattered hairs, with an occasional long one. No infrastigmatal tubercle on the third thoracic segment.....	Cinclidia.
Body sprinkled between the tubercles with pretty long, spinous, tapering hairs. An infrastigmatal tubercle on all the thoracic segments.....	Euphydryas.

* In one Pacific coast species, according to Mr. Henry Edwards, each individual makes a separate web of its own. The web constructing habit appears to be confined to and almost universal in that section of the tribe which is

best developed in the Old World and on the Pacific slope of our own country, in distinction from eastern America and the tropics. To it of our New England genera belong *Cinclidia* and *Euphydryas*.

Table of the genera, based on the chrysalis.

- No suprastigmatal tubercle on the second abdominal segment (the raised spiracle in *Phyciodes* should not be mistaken for this). No distinct black band traversing the wing-cases.
 A distinct transverse ridge connecting tubercles of fourth abdominal segment. **Phyciodes.**
 No such distinct ridge..... **Charidryas.**
 A suprastigmatal tubercle on the second abdominal segment. A distinct, obliquely transverse, black band upon the wing-cases.
 No distinct tubercles on the eighth abdominal segment, their place being marked only by dark spots..... **Cinclidia.**
 Tubercles of eighth abdominal nearly as prominent as on the preceding segment..... **Euphydryas.**

Table of the genera, based on the imago.

- Middle joint of palpi tapering considerably and regularly in apical half; fore tibia of ♂ very slender and of equal size throughout, at least ten times longer than broad.
 Apical joint of palpi less than one-third as long as the middle joint; fore tibia of ♂ scarcely shorter than the femur..... **Phyciodes.**
 Apical joint of palpi nearly half as long as the middle joint; fore tibia of ♂ much shorter than the femur..... **Charidryas.**
 Middle joint of palpi of nearly equal size throughout; fore tibia of ♂ stout and tumid, not more than five or six times longer than broad.
 Fore wing not produced apically, the outer being much shorter than the hind margin; second superior subcostal nervule arising beyond the cell; last joint of palpus more than half as broad, and nearly or quite half as long, as the middle joint..... **Cinclidia.**
 Fore wing produced apically, so that the outer margin is scarcely shorter than the hind margin; second superior subcostal nervule arising before the extremity of the cell; last joint of palpus less than half as broad, and scarcely one-third as long, as the middle joint..... **Euphydryas.**

PHYCIODES HÜBNER.

Phyciodes Hübn., Verz. bek. schmett., 29 *Melitaea* (pars) Auct.
 (1816).

Type.—*Papilio cocyta* Cram.

And here and yonder a flaky butterfly
 Was doubting in the air.

MCDONALD.—*Fulfilment.*

Imago (54: 2). Head large, furnished, not very abundantly, with long, erect hairs. Front scarcely, if at all, inflated excepting in the middle beneath, where it is rather sharply protuberant; nearly half as broad again as high, scarcely as broad as the eyes; upper portion almost flat; upper border produced rather broadly between the eyes, the produced portion transversely rounded, the border abruptly terminating at the pit of the antennae and not sloping gradually to it; lower border rather produced in the middle and strongly rounded; vertex rather large, regularly rounded but not tumid and lying below the upper level of the eyes, scarcely broader than long, the sides straight or slightly concave and narrowing posteriorly, the posterior border squarely docked. Eyes rather large, not full, naked. Antennae inserted with their posterior border in the middle of the front in distinct not deep pits, separated at their base by a space equalling the diameter of the second antennal joint; considerably longer than the abdomen, composed of thirty-four or thirty-five joints of which the last eleven or twelve compose the club, which is compressed, cylindrical, increasing very gradually and regularly in size, principally by increment upon the outside of the joints, and then diminishing rapidly, four joints entering into the diminution of size, the end being well rounded, the apex slightly conical, the whole club four times as broad as the stalk and three and a half times longer than broad; beneath with a distinct central carina. Palpi very long and not very stout, almost three times longer than the eye, directed upward and

considerably forward, the apical joint nearly one-third as long as the penultimate and clothed only with short, recumbent scales and hairs, while the other joints are supplied both above and below with very long, erect, and forward reaching scales and hairs, all in a vertical plane.

Prothoracic lobes greatly appressed, hollowed behind, except interiorly reduced almost to laminae, upper surface rounded transversely, fully three times as broad as high, the ends well rounded. Patagia moderately broad and rather long, fully three times as long as broad, the posterior lobe diminishing gradually in width, the apex bluntly rounded, the inner margin nearly straight, but gently curved, exteriorly a little concave, rendering the latter part of the posterior lobe equal.

Fore wings (39: 8) two-thirds as long again as broad, the costal margin slightly curved near the base, beyond very slightly convex, the outer angle rounded off but distinct; upper portion of the outer margin, as far as the middle of the subcosto-median interspace, straight and at scarcely less than a right angle with the costal margin; below this as far as the lowest median interspace it is slightly concave and bent inward at an angle of about 35° , below the lowest median nervule excised, the angle rather broadly rounded; inner margin scarcely concave. First superior subcostal nervule arising in the middle of the outer two-fifths of the wing; the three following at equal distances from each other and at the same distance as is the second beyond the apex of the cell; the fourth further from the outer margin than from the origin of the second; second inferior subcostal nervule arising about one-third way down the wing; cell scarcely two-fifths as long as the wing and two and half times longer than broad. Last median nervule connected with the vein closing the cell, more than half as far from its base as that is from the first median nervule.

Hind wings with the costal border rather largely shouldered and well rounded next the base, beyond straight or very nearly so, the outer angle very broadly rounded; the outer border pretty well rounded, regularly so in the ♀, rather full in the subcostal and subcosto-median area in the ♂; inner margin somewhat expanded but not very abruptly next the base, beyond straight, scarcely and roundly emarginate beyond the internal nervure, the angle rounded off. Precostal nervure directed strongly outward from its middle. Second subcostal nervule originating but very little beyond the first; cell open.

Fore legs short, cylindrical, in the male with a slight fringe of long, not greatly spreading hairs on the outer side; tibiae about two-fifths the length of the hind tibiae; tarsi about one-third (♂) or about five-sixths (♀) as long as the tibiae, composed either of a minute, apical joint and vague indications only of other incisions, unarmed (♂); or of five joints, of which the first is half as long again as all the others together; the second two-fifths of the remaining length, and the others decreasing in a regular ratio, the last being only a bulbous swelling at the tip; all but the last are furnished beneath at the tip with a pair of moderately long spines, these of the first joint rather slender and recumbent, of the others stout at base, tapering and prominent, the space between them naked; in the middle of either side of the second and third joints beneath is a single, delicate spine (♀). Middle tibiae scarcely so long as hind tibiae, furnished on either side in the middle beneath with a row of rather short, slender, tapering, somewhat spreading, distant spines, the apical ones developed as not very long but slender spurs; supplied also on the upper surface and inner side with a few, similar spines, most of them arranged in an imperfect row at the upper limit of the inner side. The first joint of the tarsi as long as the others together, the second equalling the third and fourth combined, the fourth smallest and the fifth fully as long as the third, armed beneath with four rows of short and slender, delicate spines, not so numerous as usual, the apical one of each joint a little longer than the others, and those of the two inner rows of the first joint apparently arranged alternately; upper surface devoid of spines. Claws very small, but rather stout, rather strongly falcate, tapering to a rather blunt tip, strongly compressed; paronychial double, the superior lobe as long as the claw, but slender and curving, much less bluntly pointed and scarcely tapering; inferior lobe half as long, but of the same size, curving strongly inward and forward; pulvillus moderate, nearly circular.

Abdomen slender, the upper organ of the male appendages a little depressed, conical, obliquely docked. Clasps stout, longitudinal, much more than twice as long as broad, the basal half rather tumid, the apical half tapering to a pointed, down-curved tip, incurved only at the extremity; interior tooth arcuate, aculiform, curving first inward, then backward and throughout a little upward, nearly as long as the tapering part of the clasp.

Egg. Pyriform, truncate above, broadest much below the middle, but little higher than broad, the under surface broadly rounded. Lower half pitted, thimble-like, with polygonal cells, upper half furnished with numerous slight vertical elevations extending to the flat summit; the latter covered again with hexagonal cells.

Caterpillar at birth. Head broadest above, broader than high, tapering rapidly beneath, the hemispheres well and independently rounded, the frontal triangle about three-fifths the height of the head, the whole smooth, with scattered simple hairs. Body narrower than the head, cylindrical, equal, furnished with slender hairs, seated on simple papillae arranged on each side as follows: a laterodorsal series, slightly in advance of the middle, on the thoracic and abdominal segments; a lateral series, on the anterior part of the thoracic and the posterior part of the abdominal segments; a suprastigmatal series, situated mesially or slightly in advance of the middle, on the abdominal segments only; and an infrastigmatal series, one to a segment, posteriorly situated on both thoracic and abdominal segments, besides another on the abdominal segments, anteriorly situated, and a little lower than the other. The hairs are slender, tapering, spiculiferous, directed in different ways on the different series of papillae.

Mature caterpillar. Head well rounded, very similar in form to that of *Brenthis*, broadest at the upper part of the ocellar field, scarcely tapering above, the summit broadly rounded, a very little full exteriorly, the suture between scarcely depressed, deepest in the middle, the front flattened a little; triangle slender, reaching about half way up the front, fully half as high again as broad; head covered rather sparsely on the sides and summit, scarcely at all in front, with minute tubercles emitting moderately long hairs, one tubercle, at the anterior outer limit of the summit of either side, a little larger than the others. Antennae with the second joint as long as broad, the third of the same diameter and rather more than half as long again as broad, the fourth very minute. Ocelli six in number, five in rather a strong curve, its convexity forward and a little downward, the middle three at equal distances from each other; the others a little further removed from them, the sixth behind the others, at equal distances from the first (or uppermost) and fourth with which it forms a right angle; the third, fourth and fifth are large and very prominent; the others a little smaller and much less prominent, the second slightly more so than the others. Labrum pretty large and long, longitudinally ridged, the front border broadly, roundly, but not very deeply, excised. Mandibles long and broad, but not very stout, the edge straight, denticulate, with half a dozen small, triangular, sharply pointed teeth. Maxillary palpi rather stout, short, the joints about equal in length and each considerably slenderer than the preceding joint. Spinneret exceedingly slender, not very long.

Body armed with tubercular spines arranged in longitudinal rows; they are stout, conical, somewhat higher than broad, bluntly pointed at tip, covered abundantly with minute wartlets emitting each a rather delicate, tapering, needle-like thorn, nearly as long as the whole spine and directed at an angle upward; they are arranged as follows:—a dorsal series, anteriorly placed on the first to ninth abdominal segments; a laterodorsal, mesially placed on second to third thoracic, and a little in advance of the middle on the first to eighth abdominal segments; a suprastigmatal antemedian on the first to tenth abdominal segments; and an infrastigmatal antero-median from the second thoracic to the tenth abdominal segments. The first thoracic segment has no tubercles but only many long hairs. Legs rather long, moderately slender, appressed, tapering considerably, the claws small, compressed, strongly heeled at base, beyond very slender and nearly equal, curving gently.

Chrysalis. Viewed from above the prothorax and head scarcely taper; the ocellar prominences, scarcely projecting either laterally or anteriorly, leave the front border of the head only slightly concave; viewed laterally the upper and lower surfaces of the head form a right angle with each other, the angle scarcely rounded, forming a transverse ridge connecting the tips of the two ocellar prominences; above the apex of each prominence is the starting point of a right angled, somewhat rounded ridge, running backward and a little inward. Head and whole of thorax having a common, pretty well arched curve, highest in the middle of the posterior two-thirds of the mesonotum, where its prominence is marked by a minute tubercle, and in front of this slightly depressed as far as the middle of the mesonotum. Whole front to the wing tips straight, excepting a slight prominence at the base of the ocellar prominences; basal wing tubercle but slightly prominent, pyramidal, triquetral, the upper angle extending as a rather low, equal ridge to the laterodorsal tubercle of mesonotum, where it terminates suddenly. Supernumerary tubercle about as prominent as the previous and separated from it by only a little curve. Mesonotum with a pair of small, conical, laterodorsal tubercles in the middle of the segment. Abdomen pretty well arched longitudinally, the uniformity broken a little in advance of the middle of the fourth segment, where there is a transverse, considerably elevated ridge, its edge bluntly rounded, extending across the whole segment, passing toward the anterior part of the segment below the laterodorsal line and including the tubercles in its course. Abdomen furnished with a dorsal series of very small, conical warts on the anterior part of the third to seventh segments, that of the fourth mounted on the summit of the transverse ridge; a laterodorsal series of similar warts, sometimes very small, on the first to seventh segments and also on the metathorax, those of the fourth also mounted on the transverse ridge; and on the same ridge a pair of suprastigmatal warts. Preanal button bounded by very distant, low, curving, very broad walls whose outer surface is deeply striate in lines radiating from the base of the cremaster; anteriorly each terminates in a minute, nearly spherical tubercle; cremaster on a dorsal aspect very broad and short, broader than long; the basal half equal, the apical half suddenly narrowing and rounded, the surface nearly flat though corrugated; on a side view equal, but rather sinuous, scarcely longer than broad, the apical field of anal hooklets nearly circular. Hooklets short, rather slender, the stem straight or nearly so, the crook but little enlarged, bent roundly at right angles, the pointed apex minute.

This is an American genus distributed over the greater portion of both continents but most largely developed within the tropics. In North America it reaches to the annual isotherm of 35° and in South America to the 30th parallel. In the northern continent it extends from ocean to ocean, but in the southern has not been reported west of the Andes. Several species occur in eastern North America; one of these is common throughout New England, and a second has been found on its southern and western confines, and once within its limits.

The butterflies are of small size with a fulvous ground-color above, heavily marked with black, wavy, transverse lines which often merge into each other, especially on the basal half and the marginal border of the wings; this border is preceded on the hind wings by a series of blackish dots. Beneath, the fore wings are usually orange fulvous and the hind wings of some brownish yellow tint, both marked with irregular blotches of brown or black, and traversed by delicate, curving, transverse streaks; the hind wings and sometimes the fore wings have a submarginal series of

paler, often subnacreous lunules, one of which in the upper median interspace is usually larger than the rest.

Our North American species are generally double brooded or polygoneutic, and hibernate as half grown caterpillars. All the species, probably, are dimorphic, the spring differing from the later broods. The eggs are laid in clusters and those of one species hatch in from four to ten days, according to season and locality. The species are generally abundant in individuals and the caterpillars social. So far as known those of most of the species make no web, but Mr. Henry Edwards states that in the Californian *P. pulchella* (Boisd.) "the caterpillars spin a small web, and draw the leaves of the plant together." The caterpillars feed upon *Compositae* and *Carduus*. The butterflies delight in open, sunny spots, their flight is slow and floating, but tremulous before alighting. They rarely rise more than three or four feet above the ground, and frequently alight upon low herbage, expanding their wings in the blaze of the sun.

The eggs, so far as known, are truncate pyriform in shape, scarcely higher than broad, with slight vertical ribs on the upper half and indented like a thimble-head below. The caterpillars resemble a miniature *Saturnia maia*, with their bristling fleshy tubercles, and are of a dark or violet hue, more or less striped with paler, narrow, longitudinal lines. The chrysalids are but slightly angulated, though Stoll' represents a South American species with rather prominent tubercles and ocellar prominences; the abdomen is marked by a distinct, though slight, transverse ridge on the fourth abdominal segment, surmounted by the tubercles common to the dorsum of the abdomen.

EXCURSUS XIX.—THE BUTTERFLY FAUNA OF THE EASTERN UNITED STATES AND ESPECIALLY OF NEW ENGLAND, COMPARED TO THAT OF EUROPE.

New thoughts are urgent as the growth of wings;
The widening vision is imperious
As higher members bursting the worm's sheath.
You cannot grovel in the worm's delights:
You must take wingéd pleasures, wingéd pains.

GEORGE ELIOT.—*Spanish Gypsy.*

If we go outside the United States to look for a butterfly fauna most closely resembling our own, we shall certainly have to seek it in the north temperate zone; and shall find there indeed no great difference, viewing the matter in a broad light; no such differences for instance, as one would find in going to a tropical country. But the resemblance, when we come to the details, and indeed in some of its wider features, is not so strong as is generally believed.

Writers, in comparing the insects of Europe and America, have usually called attention to their similarity; and since these regions are embraced between the same isothermal lines and nourish the same cereals, we should naturally look for a great resemblance. But if we compare the butterflies of the better known districts, such as eastern North America and Europe omitting from each the extreme southern species, we shall find, to start with, that eastern America is poorer than Europe, having about one-fifth less butterflies. Or if we make the comparison family by family we shall discover first, that while half of the European butterflies are brush-footed butterflies (Nymphalidae) less than one-third of the American butterflies belong to this family. The gossamer-winged butterflies (Lycaenidae) are also proportionally a little less abundant in America than in Europe, while the typical butterflies (Papilionidae) are slightly more abundant. The balance on the American side, however, is made up in the lowest family, since nearly one-third of the American fauna is composed of skippers (Hesperiidae) while scarcely more than one-tenth of the European fauna is composed of this family. As contrasted with each other, then, Europe is peculiar for its wealth in brush-footed butterflies, America in skippers.

The disparity of representation is rendered more striking when we compare the minor groups. We will not here enter into many details, but only point out the following facts: first, that the great disparity of numbers in the brush-footed butterflies on the two continents is almost wholly due to the vast number of meadow-browns (Satyrinae) in Europe—it has seventy-seven species while we have but nineteen; second, that the preponderance of skippers in this country is due to the great proportion of the Pamphilidi or smaller skippers, which number forty-four with us, against nine in Europe; third, that while the hair-streaks (Theclidi) are twice as numerous in America as in Europe, twenty species against ten, the balance in the sub-family is more than restored by the superior number of blues (Lycaenidi) in Europe, where there are thirty-eight species to our thirteen; fourth, that while the numbers of the typical butterflies on the two continents are almost equal, there is no similarity of representation in the groups composing the family, excepting in the whites (Pieridi) where there are eight in Europe and five in America; for the orange-tips (Anthocharidi) number seven in Europe and two in America, the yellows (Rhodoceridi) ten in Europe and twenty in America, the swallow-tails (Papilionidi) three in Europe and nine in America, and the Parnassians (Parnassidi) six in Europe and none in America.

Notwithstanding such striking contrasts, there are many apparent resemblances; but upon analysis nearly all of these disappear. Take, for example, the two most striking cases, the Vanessidi and the Hesperidi, in both of which the numbers are virtually the same in the two coun-

tries; in the latter only two of the eight American and four European genera are common to both countries, and in these two the representation is very unequal, one genus, *Thanaos*, having six* species in America against two in Europe, and the other, *Hesperia*, fourteen in Europe and two in America.

In the *Vanessidi* there are eight genera, of which four are represented on each continent, the others being equally divided between the two countries. We have naturally in this instance a closer resemblance than in any other group of butterflies, because its genera are mainly genera of the north temperate zone and include some forms common to the two continents.

In other groups the differences are very observable. Thus, of the nine American genera of *Theclidi*, but one is represented in Europe, and even in this group (*Thecla*) the European species have a peculiar facies distinct from the American. Only one of the seven American genera of *Rhodoceridi*, and two of the seven American genera of *Papilioninae* are found across the Atlantic; and in the *Pamphilidi* only three or perhaps four of the twenty-three genera found in America occur at all in Europe. Or, if we sum up the whole, we may say that of the one hundred and five American genera of butterflies, only twenty-seven or twenty-eight (or about one-fourth) are represented in Europe; and of the others, there are but seven intimately related to European genera.

A careful study of all other points of resemblance between the two countries will show that they are almost all confined to groups which are boreal in their aspect; while, if we had excluded from the comparisons the species inhabiting in either country the high north, and had included those of the extreme south, not only would the number of species in either country have been considerably augmented, but the resemblances would have been greatly diminished, and the differences more than proportionally increased. Nor would the differences appear at their real value if account were not taken, as here, of the lesser structural features for generic distinction.

In the table on the next page the relative number of species of the different groups of butterflies in Europe and eastern North America is shown, the European species being taken from the last edition of Staudinger and Wocke's Catalogue, omitting the purely Mediterranean forms, as the species peculiar to the Gulf States have been omitted from the American.†

* Even this large number has been greatly increased latterly.

† This list was first published in 1876, in the Proceedings of the American association for the advancement of science, and on the American side should undoubtedly under-

go some change from later discoveries, but as the changes would not essentially disturb the comparisons to which attention is here directed, I have not thought it worth while to revise it.

It should be remembered that we are here dealing only with eastern America and Europe, contiguous portions of two worlds. Had the com-

NAME OF GROUP.	NUMBER OF SPECIES.		PERCENTAGE OF TOTAL FAUNA	
	Europe.	America.	Europe.	America.
Satyrinae.....	77	19	30.8	9.2
Euploeinae.....	0	2	0.0	1.0
Apaturidi.....	3	3	1.2	1.4
Nymphalidi.....	5	3	2.0	1.4
Vanessidi.....	11	11	4.4	5.3
Argynniidi.....	20	16	8.0	7.7
Melitaeidi.....	14	10	5.6	4.8
Nymphalinae.....	53	43	21.2	20.8
Libytheinae.....	1	1	0.4	0.5
<i>Nymphalidae</i>	131	65	52.4	31.4
Lemoniinae.....	1	2	0.4	1.0
Theclidi.....	10	20	4.0	9.7
Lycaenidi.....	33	13	15.2	6.3
Chrysophanidi.....	8	8	3.2	3.9
Lycaeninae.....	56	41	22.4	19.8
<i>Lycaenidae</i>	57	43	22.8	20.8
Rhodoceridi.....	10	20	4.0	9.7
Anthocharidi.....	7	2	2.8	1.0
Pieridi.....	8	5	3.2	2.4
Pierinae.....	25	27	10.0	13.0
Parnassidi.....	6	0	2.4	0.0
Papilionidi.....	3	9	1.2	4.3
Papilioninae.....	9	9	3.6	4.3
<i>Papilionidae</i>	34	36	13.6	17.4
Hesperidi.....	19	18	7.6	8.7
Pamphilidi.....	9	44	3.6	21.3
Castniadi.....	0	1	0.0	0.5
<i>Hesperiidae</i>	28	63	11.2	30.3
Total.....	250	207	100	99.9

parison been made between western America and eastern Asia, it would have shown far stronger affinities, at least in the relative development of the principal groups.

Table of the species of Phyciodes, based on the imago.

Under surface of hind wings usually with a varied ground tint, large patches of dark color contrasting strongly with a lighter base; a large, more or less clouded, dark marginal patch in the middle of the hind border invariably present and generally very distinct. Tip only of ♂ clasps bent downward.....*tharos*.
 Under surface of hind wings with a very uniform tint, all the markings delicate and subobsolete; the marginal patch of hind border, if present at all, obscure. Whole of apical half of ♂ clasps bent downward.....*batesii*.

PHYCIODES THAROS.—The pearl crescent.

[Pearl crescent fritillary (Gosse); pearl crescent (Seudder); Pharos butterfly (Harris); light-house melitey (Emmons); little black bordered butterfly (Maynard); the drappled Melitaea (Ross).]

Danaus festivus tharos Drury, Ill. nat. hist., i: 43-44, pl. 21, figs. 5-6 (1770).

Papilio tharos Cram., Pap. exot., ii: 112, pl. 169, figs. E. F. (1779);—Herbst, Natursyst. ins. schmett., ix: 203-204, pl. 260, figs. 4-5 (1798).

Melitaea tharos Poey, Cent. Lep. Cuba, (1832);—Boisd.-LeC., Lép. Am. sept., 170-171, pl. 47, figs. 3-5 (1833);—Morr., Syn. Lep. N. Amer., 51, (1862);—Mayn., Butt. N. E., 27-28, pl. 4, figs. 32, 32a, 32b (1886).

Eresia tharos Steph., Ill. Brit. ent., Haust., i: 150 (1828).

Melitaea (Phyciodes) tharos Doubl.-Hewits., Gen. diurn. Lep., i: 181 (1848).

Phyciodes tharos Kirby, Syn. cat. Lep., 172 (1871);—Edw., Can. ent., ix: 1-10, 51-58 (1877); Butt. N. Amer., ii, Phyciodes, i, ii, 18 pp., 2 pl. (1878);—French, Rep. ins. Ill., vii: 151 (1878); Butt. east. U. S., 177-180 (1886);—Fern., Butt. Me., 49-51 (1884).

Argynnis tharossa God., Encycl. méth., ix: 256, 289 (1819).

Melitaea pharos Emm., Agric. N. Y., v: 212-213, pl. 43, figs. 5-6 (1854);—Harr., Ins. inj. veg., 3d ed., 289-290, figs. 116-117 (1862).

Papilio morpheus Fabr., Syst. ent., 530 (1775);—Herbst, Natursyst. ins. schmett., ix: 201-202, pl. 260, figs. 1-2 (1798).

Papilio cocyta Cram., Pap. exot., ii: 148, pl. 101, figs. A-C. (1779).

Papilio euclea Bergstr., Nomencl. ins. Hanau, iv: 23-24, pl. 19, figs. 1-2 (1780);—Herbst, Natursyst. ins. schmett., x: 159-160, pl. 284, figs. 9-10 (1800).

Melitaea selenis Kirby, Faun. bor.-am., iv: 289 (1837).

Figured by Abbot, Draw. ins. Ga. Brit. Mus., vi: pl. 43, figs. 38-40 (ca. 1800);—Glover, Ill. N. A. Lep., pl. O. fig. 9, ined.

PHYCIODES THAROS MARCIA.

Spring form.

Melitaea marcia Edw., Trans. Am. ent. soc., ii: 207-209 (1868);—Grub., Jen. zeitschr. naturw., xvii: 477-478, pl. 8, figs. 28-29 (1884); Pap., iv: 90, pl. 3, figs. 28-29 (1884).

Phyciodes tharos, form *marcia* Edw., loc. cit. (1877-78).

PHYCIODES THAROS MORPHEUS.

Summer form.

Phyciodes tharos, form *morpheus* Edw., Can. ent., ix: 55 (1877);—Butt. N. Amer., ii, Phyciodes, i, ii (1878).

Melitaea tharos Grub., Jen. zeitschr. naturw., xvii: 478-479, pl. 8, fig. 33 (1884);—Pap., iv: 90, pl. 3, fig. 33 (1884).

Drury's tharos and Cramer's cocyta quoted above are thought by Edwards to belong to this form.

Then flutter thou
Close by his foot like gilded butterfly.

HOGG.—*The Haunted Glen.*

أَطْيَشٌ مِنْ فَرَاشَةٍ —Atyash min farashat.—Fickle as a butterfly.
Arabic proverb.

Imago (5:1, 3; 12:1, 3). Head covered with black scales, mostly concealed by greenish fulvous and brownish fulvous hairs, below the base of the antennae by tawny fulvous hairs, changing below, toward the tongue, to a commingling of dull fulvous and dirty white scales; behind the eyes covered above with mingled yellow fulvous and dusky scales, below with whitish scales. Basal joint of palpi and basal third of middle joint pure white externally; beyond, pale yellowish fulvous, with scattered black scales; apical joint a little darker, minutely tipped with white; fringed beneath with mingled white and dusky-tipped fulvous hairs, the former diminishing toward the tip; above with brownish fulvous hairs, with a few intermingled black hairs; inner similar to the outer side, but more besprinkled with black scales. Antennae blackish brown above, sometimes enlivened, especially on the basal joints, with dull fulvous,* and narrowly annulated, at the base of each joint, with white;

* Occasionally the dull fulvous predominates, producing quite a different appearance.

outer lower surface white, inner lower surface yellowish brown, the two somewhat intermixed; under surface of club and the whole tip, including four or five joints, dark orange; above, excepting the tip, blackish brown, the white streak on the lower outer surface reaching the orange portion of the tip. Tongue pale brownish fuscous, basal quarter pale luteous; papillae (61:40) less than a dozen and a half in number on each maxilla, widely separated, about as long as the width of one maxilla, cylindrical, somewhat appressed, about four times as long as broad, the apical ones more rounded and elongate-ovate, the edge of the cup sharp, the central filament shorter than the width of the papilla, bluntly tipped, slender and cylindrical.

Thorax covered above with greenish brown hairs, on prothorax and patagia strongly tinged with fulvous; beneath white, faintly tinged with buff on the metathorax. Fore legs very pale fulvous externally, beneath white; other legs pale tawny fulvous, the femora white beneath. Spines and spurs of the color of the upper surface of the legs; claws castaneous; pulvillus blackish.

Wings above varying from pale to deep orange (often varied with clustered or independent scales of buff yellow, especially on the apical half of the fore wings in the female) heavily marked with blackish brown. *Fore wings*: The veins mostly blackish; the basal three-fifths of the costal border broadly, and the whole inner border narrowly, edged with black; on the basal three-fifths of the wing are, normally, two transverse bands, besides the spot occupying the base; the latter extends one-third the distance toward the extremity of the cell, and is seldom enlivened by any orange markings, although frequently speckled extensively with greenish yellow scales; the inner transverse band consists of a series of broad rings, flattened at their junction on the nervures and in the middle of the cell, their sides formed of opposed curves, the whole as broad as, some broader than, the marginal interspaces, forming an arc of a circle whose centre is at the base of the wing, the outer border removed from the apex of the cell by its own width or even less, and including orange spots, sometimes obscured with greenish yellow scales, sometimes obliterated with blackish; the inner edge of this band, and almost always its lower extremity, is obscured by blackish in the surrounding parts; the outer band is usually (♂) or sometimes (♀) broken; its outer limit, starting from the costal border, at three-fifths the distance from the base, runs downward and outward, in a nearly straight, oblique line, to the upper median nervule, striking it at one-third the distance from its origin; here it turns abruptly inward and crosses the upper median interspace, at the middle of its widening portion, by a deep lunule opening outward; the rest of the outer border has a curved or oblique limit, curving in the lower median interspace, and then turning obliquely outward, reaching the black inner border at about three-fifths the distance from the base of the wing; when the band is broken it is at the lower median nervule, and even the upper median interspace is quite devoid of any sign of it; the inner limit of the band varies greatly and is frequently obscure; but the upper part of the band is formed by an oblique, elongated, triangular patch, depending from the costal border and reaching the upper median, narrowing as it goes, at first greatly, afterwards more gradually; the lower half is formed of a broad belt, at least in the medio-submedian interspace, whose inner margin crosses the nervures at about right angles, running downward from a point generally about midway between the two divarications of the median nervure; between these two bands, and, usually (at its upper, outer extremity, if not altogether) merged in the outer one, is a slender, ovoid, transverse, black circlet, its inner edge marking the extremity of the cell; these markings are very frequently more or less blurred, and sometimes are slightly flecked, especially in the middle and lower half of the wing, with greenish yellow scales, but the extreme base of the median interspaces, and the lower portion at least of the subcosto-median interspace, just beyond the cell, are generally devoid of black scales, even when the band is continuous and the wing most obscured, or if they are present, they are not clustered. The outer margin is broadly bordered, to the width of an interspace, with black, followed by an obsolete series of faint, delicate, orange or buff orange, or greenish yellow lunules opening outward, and in the upper median interspace by an open orange space;

the lunules are always faint, and very frequently, especially in the male, altogether imperceptible, and are immediately followed, above the upper median interspace, by a broad, transverse black patch, confluent with the marginal band, when the lunules are absent; below the upper median interspace by a similar broader patch, its interior portion extending somewhat into the upper median interspace. The upper patch is followed interiorly by an orange patch, broadening downward, and distinct only on the two lower submedian interspaces, followed in its turn by a transverse, triangular black patch, often attenuated below, reaching the middle of the subcosto-median interspace, and having an interior border subparallel to the exterior border of the mesial band, and separate from it by about twice the width of an interspace; about midway between the interior border of the lower submarginal patch and the exterior border of the lower portion of the mesial band, is a zigzag stripe, generally slender, sometimes, in the female, and especially toward the inner border, moderately broad, with a bend in each interspace and at each nervule; it runs from the upper median nervule, sometimes connected with the lower extremity of the upper triangular black patch, sometimes with that of the upper portion of the mesial stripe, sometimes between them to the inner border, and has a general direction at right angles to the nervules; a small black spot is sometimes seen (especially in the female) in the medio-submedian interspace, midway between the zigzag stripe and the submarginal black patch; fringe blackish brown at base, beyond varying from blackish brown to dirty white, rather broadly interrupted with brownish at the nervule tips, excepting at the apex of the wings. Base of the *hind wings*, half way to the first divarication of the subcostal and median nervures, and the basal half of the medio-submedian interspace, blackish; outside of this are two pairs of transverse, often tremulous black lines, each set forming the borders of an open band; the interior band, often partially obscured by the duskiess of the base, crosses the cell at the middle of the inner two-thirds, forming, approximately or exactly, the figure 8; the exterior starts in the costo-subcostal interspace by a coarse, arching streak, spanning the first divarication of the subcostal nervure; the inner line continues along the apical boundary of the cell, marking its limits, while the outer crosses the interspace beyond it at about the distance of the width of an interspace, sometimes uniting at both ends with the inner line; with opposing curves, and forming a still open band of similar width, the two lines cross the lower median interspace just within the second divarication of the median nervure and terminate. The outer border, for about the width of an interspace and a half, is margined with black, but is enlivened at about the distance of an interspace from the border by a series of delicate, often partially obsolete, greenish yellow or faint orange lunules, opening outward; scarcely removed and equidistant from the interior margin of the black border, is a series of seven small black spots, minute and round above, growing larger and more transverse toward the inner border; a little further removed inward from this series than this is from the black bordering, is a vague, sinuous, black line, subparallel to the outer border, generally obsolete for a considerable space in the middle of the wing, increasing in importance as it passes toward either border, terminating next the inner border at the internal nervure, which it follows downward to the outer bordering,—next the costal border, following in a similar manner the costal nervure; between this line and the outer border the veins are black; fringe as in the fore wings.

Beneath: *Fore wings* pale orange, more or less distinctly tinged with ochraceous along the costal border, at the extreme apex and in the middle of the outer border; the mesial black stripe is repeated beneath with equal or nearly equal distinctness, as is also the triangular black patch depending from the costal border about midway between the mesial stripe and the apex of the wing; it is sometimes followed, especially in the female, by a slender stripe of whitish scales; crossing the medio-submedian, the lower median, and sometimes, less broadly, the upper median interspace, is a broad, transverse, black stripe; the other black markings of the upper surface, and especially on the basal half of the wing, are indicated beneath by a greater depth of orange; a transverse, wavy, cinnamoneous line, arched inward in each interspace,

crosses the outer part of the wing, parallel to the outer border and distant from it by half the width of an interspace; occasionally the outer margin of the wing, and especially the upper half of the female, is broadly besprinkled with grayish scales, giving it a more or less hoary appearance; outer border edged delicately with cinnamoneous; fringe much as on the upper surface. *Hind wings* ochraceous, the basal three-fifths of the wing occupied by irregular, discontinuous, somewhat intercurrent, transverse, curving, cinnamoneous lines, subparallel to the outer border; they can with difficulty be resolved into five nearly equidistant sets, the antepenultimate, counting from the base, crossing the cell and marking its extremity; the outermost starts from the costal border at two-thirds the distance from the base, and terminates at the middle of the outer half of the internal nervure, crossing the subcosto-median interspace at fully one-third the distance from the extremity of the cell; the extremity of the cell is often occupied by a large, vaguely limited, cinnamoneous brown spot, and other smaller and fainter, but equally vague spots occasionally occur between contiguous lines, particularly on the internal half and costally above the first divarication of the subcostal nervure; not infrequently the outer half of the cell is filled with a darker, more widely extended, brownish spot, scarcely tinged with cinnamoneous, and in this case the space between the two outer lines, as well as sometimes the two borders of the wings, are paler than usual, forming a distinct band; in extreme cases, the discal spot is still deeper in color, approaching blackish fuscous, and the band becomes of a silvery gray, presenting a striking contrast, more common in the female than in the male, to what appears to be the normal pattern. Midway between the outer line and the outer border of the wing is an arcuate row, parallel to the latter, of six small, round or transverse, blackish spots, largest in the middle of the wing; next to the outer margin is a series of continuous, linear, dark cinnamoneous or blackish crescents, similar to the submarginal series of the fore wings, frequently followed, especially in the female, by a second similar series, as far from it as it is from the border; the latter series is often wanting in the upper half of the wing; next the exterior limit of the outer line of the basal series, and following it from the costal border to the middle subcostal nervule, occurs a broad, sometimes partially obsolete patch of color, varying, according to the other parts of the wing, from cinnamoneous brown to dark brownish fuscous; the outer border of the wing in the subcostal and median area has a common broad arched patch, including by its height some of the round, blackish spots, but seldom obscuring any of the markings of this region, varying from a pale cinnamoneous brown to fuliginous, but usually enlivened in the upper median interspace (occasionally, to a much less extent, also in the next interspace above) between the two linear lunules, and sometimes as far as the outer margin, by an ochraceous silvery, silvery gray or grayish fuliginous, high lunule, which the outer linear lunule divides in two, if not, as occasionally, obsolete; in the darkest, most pronounced individuals (the extreme of *P. t. marcia*) this large marginal spot joins the extramesial spot of the costal margin, and spreads across the whole wing, occupying as a fuscous area, in strong contrast to the silvery mesial band, the whole outer half of the wing, relieved only by the silvery marginal lunule of the upper median interspace and a large, silvery gray patch at the apex of the wing; more or less distinctly the latter pale patch is present in all infuscated specimens; in some of the darker individuals the space between the two submarginal series of linear lunules, or, still more seldom, the whole margin as far as the inner series is of a slightly paler fuliginous than the neighboring tints; and sometimes a pale ochraceous or pale silvery gray spot occurs at the anal angle, similar to, but smaller than that at the apex of the wing; the outer border is delicately edged with cinnamoneous or blackish; fringe as on the upper surface.

Abdomen above and on sides blackish brown, besprinkled with a few fulvous scales on the sides and toward the extremity of the body above, especially at the tips of the segments; beneath white, occasionally marked, in the middle of the segments, by subventral touches of fulvous. Appendages of male: clasps tapering from the base to the tip when viewed from the side, but with a pretty well marked division into a basal

and an apical half; comparatively little compressed, even in the apical half, the tip only bent downward.

Measurements in millimetres. Length of tongue, 7 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	14.5	16.75	19.	12.25	18.5	20.5
antennae.....	8.	9.25	10.	7.	9.5	10.5
hind tibiae and tarsi..	5.	6.	6.5	4.1	6.	6.75
fore tibiae and tarsi..	1.6	2.	2.25	1.75	2.25	2.45

Described from 96 ♂, 40 ♀, and 27 uncertain; of these about one-fifth were *P. t. marcia*.

The largest New England specimen I have seen was one received since these measurements were taken. It is a ♀ captured at Blanford, Mass., by Dr. G. Dimmock; the fore wing measures 21.5 mm. in length.

Aberrations. *P. t. packardii* (*Melitaea packardii* Saund., Pack. Guide ins., 256-57; figured in Edw., Butt. N. Amer., ii, Phyciodes, ii). Dr. J. C. Merrill captured at Nahant, Mass., a remarkably suffused male, hardly recognizable as belonging to this species. The upper surface is almost entirely blackish brown, the only orange fulvous present on the *fore wings* being a small, transverse spot at the extremity of the cell bordering the limiting vein, a transverse series of small, round spots, corresponding to the interior of the chain crossing the middle of the cell, and a transverse series parallel to the outer border, of five larger lunules, with blurred borders, in the middle of the outer half of the wing, the middle one, in the upper median interspace, largest, decreasing rapidly on either side. A similar disposition is shown on the *hind wings*; two partially confluent, curving bands occupy the two chains of circlets in the basal half of the wing, while a slender series of fulvous lunules, in the middle of the outer half of the wing occupy, normally, the position of an outer bordering to the transverse, wavy, black lines beyond the middle of the wing. Beneath, the appearance is, if anything, still more remarkable. The *fore wings* are dull tawny, the outer two-thirds of the costal and the middle half of the inner border with broad, rounded patches of blackish fuscous, excepting a slight dash of greenish yellow in the middle of the former just below the costal edge; and a not very broad, submarginal, blurred fuscous stripe, vaguely formed of lunules, distant about the width of an interspace from the outer border, and beyond which the border, except in the upper median interspace, is strongly tinged with ferruginous. The *hind wings* are of the usual tint, but the markings differ from the type in altogether wanting the streaks of the basal half of the wing and in being marked instead by a pair of faint, broad, partially interrupted, curving, dull fulvous bands, one crossing the wing just within the termination of the cell, the other a little way beyond it; the round spots are faint and fulvous, and the double row of submarginal lunules is supplanted, as on the *fore wings*, by a single series of coarse, cinnamoneous, brown lunules; the other apical markings are as in the usual type.

Another somewhat similar specimen (but a female of the *marcia* type) is one first described as a distinct species under the name of *Melitaea packardii*. It differs from the male described above only in the greater extent of the fulvous markings, especially on the outer half of the *fore wings*, where they form a very broad belt in the middle of the outer half, broken only by the blackish nervures. Below, it differs from the male in the following respect: on the *fore wings* the fulvous tint is deeper and purer, the costal and inner margins are less infuscated and the submarginal streak is supplanted by the inner series of linear lunules, just as they occur in the normal types, indeed more distinctly, yet as delicately, and continuous across the wing; beyond it, the upper two subcostal, the upper median and the medio-submedian interspaces are ochraceous. The *hind wings* are marked more distinctly at the base than in the male, and in place of the broad, faint, mesial band, the position of its inner border—that is, the tip of the cell—is occupied by a narrow, ill-defined, cinnamoneous, brown stripe, beyond which the wing is almost wholly dull yellowish silvery, excepting a larger, very high, dull brownish, marginal lunule in the lower median and subcosto-median

interspaces; and excepting also a slender lunule of the same within the middle of the upper median interspace and a faint wavy streak of similar, ill-defined lunules occupying, in the upper half of the wing, the position of the inner series of linear lunules; outer edge cinnamomeous.

At first glance I referred this to *Charidryas nycteis* from the silvery appearance of the under surface of the wings; but examination of the structure and the markings left no doubt that it was to be referred to the present species, and this feature to the silvery gray of the form *marcia*. I owe to Mr. Saunders an opportunity of studying the original specimen, which has also been figured by Mr. Edwards, as noted above.

Dimorphic forms. The two forms of this species are distinguishable mainly in the color and markings of the under surface of the hind wings, which have a yellow-buff ground color in *morpheus*, with comparatively inconspicuous or obsolete markings, especially in the male; while in *marcia* the ground color ranges from bright yellow to ferruginous, with heavy and strongly contrasted markings, either from the intensity of the cloudy infuscations or the subnacreous tints of the lighter parts, or both. In addition to dimorphic diversity, *marcia* is highly variable, Mr. Edwards distinguishing four distinct types with intergrades between, the heaviness of the markings and the divergence from *morpheus* becoming more and more marked from north southward. This refers only to the heaviness of the markings beneath, though Edwards distinctly refers to the heaviness of the markings of the upper surface of *P. t. morpheus* from Texas. It so happens, on the other hand, that I have seen no individuals so heavily marked on the upper surface as some of the same summer form which I took at the mouth of the Saskatchewan, though others were of an ordinary character.

Egg (64: 31). Tapering so that the truncate summit is half the diameter of the egg; the polygonal cells of lower half shallow, saucer-like depressions about .03 mm. in diameter, which become more and more indistinct below. Vertical ribs eighteen to twenty-five in number and merely the culminating rounded ridges of wave-like depressions of the surface; some of them unite before reaching the margin of the truncate summit; the interspaces between these is sometimes feebly and indistinctly broken by wrinkle-like cross marks into cells about twice as broad as high. Cells of flat summit decreasing in size toward the centre (67: 15), around which their longer diameters radiate, the outer cells about .04 mm. and the inner cells about .0125 mm. in longer diameter; the boundaries of the cells are sharply defined, delicate lines. Color light yellowish green, glistening. Height .5 mm.; breadth .45 mm.; breadth of summit, .23 mm.

Caterpillar. *First stage* (72: 6). Head (79: 12) glistening, dark, olive green, the scattered hairs curving, simple and white; ocellar field black, the ocelli pallid; mouth parts and antennae pale green. Body and papillae very pale green. Hairs generally half as long again as the width of the body, black, arcuate; those of the laterodorsal and lateral series curving backward, the lateral less arcuate and smaller; of supra-stigmatal nearly straight, of infrastigmatal the anterior directed outward and downward, the posterior only outward; prolegs color of body, the legs green, but infuscated. Length, 2 mm.; breadth of head, .28 mm.

Second stage. Head luteo-piceous with a slight, luteous, oblique stripe on either side above, smoothly rounded, with scattered pale hairs as long as the depth of the head. Labrum luteo-testaceous. Body pallid, with the fleshy, conical, apically blunt tubercles two or three times as high as broad, armed with brown, faintly spiculiferous, acicular spines fully as long as the tubercles and arising from slight papillae. Dorsal region faint, greenish brown, deepest on the thoracic segments, interrupted by the tubercles on the abdominal segments and most marked here in an open ring, surrounding the tubercles excepting in front and sending off divergent branches in the posterior lateral corners; a broad, brown lateral band, interrupted by the supra-stigmatal tubercles. Spiracles on elevated, fuscous-tipped tubercles, circular. Legs pale greenish fuscous; prolegs pallid. Length, 3.25 mm.; breadth of head, .42 mm.; length of tubercles, .15 mm.

Third stage. Head (79: 13) shining blackish brown with a pallid triangle, a pallid or luteo-pallid, scarcely oblique, broad stripe longitudinally across the top of each hemisphere and a similarly colored patch at base of mandibles extending the color of the triangle in this quarter; scattered fine, pale hairs as long as the depth of the head. Labrum luteous, fusco-testaceous at base; antennae pallid with a fuscous tip. Body greenish, olivaceous brown, much mottled with darker and lighter tints, darker on the sides than on top, with moderately broad, pallid, greenish laterodorsal and infrastigmatal stripes, involving to some extent, as do the other longitudinal markings, the color of the tubercles, these being almost wholly pallid in the laterodorsal and infrastigmatal series, more or less infuscated elsewhere; but the spines are more or less embrowned in all of them. The tubercles are of nearly the same character as in the preceding stage. Legs and prolegs as there. Length, 5 mm.; breadth of head, .56 mm.; length of tubercles, .25 mm.

Last stage (72: 6, 9). Head (72: 8; 79: 15) shining bronze with black hairs; across the summit a narrow whitish bar, thickened at the front of each side, and bluntly barbed on the outside; in front a triangular spot connecting at the lower angle with a sickle-shaped bar on the side. Body, blackish brown, dotted, especially on dorsum, with yellow; the spines stout at base and there mostly yellowish; the bristles brown, black tipped; a black dorsal stripe often wanting; a yellow stripe following the laterodorsal spines and a band of the same color the infrastigmatal series; sometimes there is a black lateral band. Length, 21.5 mm. (after Edwards, my own description having been lost).

Chrysalis (84: 20-22). Grayish white, the abdomen a little darker; surface minutely corrugated and dull whitish, the crevices filled with pale, yellowish brown, more profusely along the anterior portions of the abdominal segments, on most of the warts and especially upon the borders of the top of the head; ocellar ribbon immaculate; wings with a dusky central spot and smaller dusky spots at the nervule tips. On the abdomen there is an inconspicuous, narrow, interrupted, dull yellowish, substigmatal band, followed beneath by a band formed of a few fuscous spots; there is also a faint trace of a dull yellowish band, following the laterodorsal row of warts, Spiracles brown, margined with pale. Length, 10.3 mm.; width at extremity of head, 2.25 mm.; at mesothorax, 4 mm.; at fourth abdominal segment, 4 mm.; height at thorax, 3.6 mm.; at fourth abdominal segment, 4.5 mm.

Comparisons. The present species differs unmistakably from the Gulf species, *P. gorgone* (Hübner) (*P. phaon* Edw.), although some specimens of the latter do approach the darker individuals of *P. tharos* very closely; on the upper side of the fore wings, a mesial, pale, almost whitish belt is always to be distinguished, and usually separated by a black streak from a submarginal orange fulvous band; although the two are usually confluent as one irregular patch in *P. tharos*, some females have them distinctly marked, but always entirely or nearly concolorous; the black outer border of both wings is broader on an average than in the present species, and, in consequence, the submarginal bright colored lunule in the upper median interspace of the fore wings is always entirely enclosed within it. Beneath, the distinctions above alluded to as occurring on the upper surface of the fore wings are brought out quite as distinctly; the prevailing color of the hind wings is quite different, that of *P. gorgone* being of a slightly dirty white, tinged with greenish, while the markings, almost an exact repetition of those of *P. tharos*, are of a blackish brown. As the Gulf species seems to have a range of variation of

almost precisely the same nature as *P. tharos*, infuscated specimens scarcely differ from those of *P. tharos* in the appearance of the under surface of the hind wings. *P. gorgone* is a slightly smaller species.

Distribution (22:3). *P. tharos* has a very extensive range, occupying almost the whole of North America, north of Mexico and the Gulf, and east of the continental divide, as far as about Lat. 53° N. At its southern limits it has been reported from northern (Chapman) but not from southern Florida, from Alabama (Gosse), central (Belfrage) and southern Texas (Aaron). To the north it has been found in Nova Scotia "very common" (Jones), Cape Breton (Thaxter), the southern side of the mouth of St. Lawrence (Bell), Anticosti (Couper), Saw Bill River, southern Labrador (Couper), in western Newfoundland (where it was taken by Dr. E. G. Gardiner at St. Barbé's Bay, about Lat. $51^{\circ} 15'$) but not reported by Gosse from eastern Newfoundland, Cacouna and Ha Ha Bay (Saunders), Quebec (Bowles), Ottawa (Billings), Sugar Bush Lake, Bevas Lake and Devil's River (D'Urban), Lake Superior (Agassiz), Lake of the Woods (Dawson), Moose Factory, Hudson Bay "very plentiful" (Weir), the mouth of the Saskatchewan River, about Lat. 53° (Seudder), Edmonton (Geddes), Upper Liard River (Dawson), McKenzie River (Edwards) and Lake La Hache, British Columbia, Lat. $51^{\circ} 51' N.$ (Croteh). The last mentioned is the westernmost ($121^{\circ} 40'$) known locality, and the only one recorded from the western watershed, though Edwards states (Bull. U. S. geol. surv. terr., iv: 515) that it is found "quite at the Pacific" to the north of our territory. In our own country it is known to occur as far west as Milk River (Coues) and the Judith Mountains, Montana (Edwards), western Dakota, plentiful (Allen), the Big Horn Mountains, northern Wyoming (Edwards), in the mountains of Colorado (Reakirt, Mead) and the mountains of New Mexico (Snow); to the east it is recorded from, and certainly occurs in, every state of the Union.

In New England it is almost everywhere exceedingly abundant; it is not uncommon even in the White Mountain district, where I have taken it above the timber; but Prof. S. I. Smith who has collected largely in Norway, Me., wrote in 1869 that he had never seen a dozen specimens there, and that year not one, and in Stow, Vt., Miss Soule only saw one or two specimens in 1885 and only one in 1886. The butterfly may be seen in almost any open sunny place, on weedy hillsides, or among the ranker vegetation following the course of small streams; it is partial to flowers, especially such as grow in low, damp ground. In Iowa, Mr. Allen found it both in the groves and on the open prairie, but it is essentially a butterfly of the open country.

Oviposition. The eggs are laid in clusters (64:29) always on the leaves of the food plant "and usually on the under side of them, in rows

nearly or quite straight, and touching each other" (Edwards). Mr. Mead found the clusters to vary from 20 to about 150 eggs. Mr. Edwards at a later date from 50 to 225. Recently an imprisoned female laid for me on the under side of a leaf about three inches from the top of the stalk a cluster of eggs, closely crowded in a mass, one side of which was straight, lying against the midrib, the other an irregular curve, the mass being about twice as long as broad. There were about one hundred eggs in the cluster, most of them lying in a single layer about as closely crowded as possible, but the outer ones a little scattering; on the top of them was a second layer of about a quarter as many, also closely crowded, but not quite so regularly erect, some being tipped a little, doubtless from the irregularity of the base. In another case, fifty or sixty were laid, closely crowded together but all in a single layer. In another instance an imprisoned female laid seven scattering eggs on one leaf, none touching the others. A day before hatching the eggs rapidly become discolored. Mr. Edwards gives the period of the egg stage at from four to seven days. At Cambridge mine have hatched in about eight days, and Professor Hamlin found the period ten days at Waterville, Me., in July.

Food plant. The food plant of this most common butterfly was for years a puzzle, and I have myself followed the females for many an hour in the vain search for some sign of its oviposition, a much more difficult task with those which lay eggs in clusters than with butterflies which lay but one egg at a time. Mr. T. L. Mead at last solved the problem, by guessing at the Compositae (as they were the food plant of other *Melitaeidi*), enclosing growing plants of a number of different kinds in a box, and imprisoning in this artificial garden the female butterflies. In a few days they selected *Aster novae angliae*, on which to deposit eggs, and this species seems to be their favorite food plant, though they will feed on any asters, but not with equal freedom. Mr. Edwards once obtained eggs laid by an imprisoned female on *Chelone*, but he did not raise them. Miss Middleton (Rep. nox. ins. Ill., x: 83) gives *Actinomeris* also as a food plant; not unlikely it may be forced to eat this, but it is hardly probable that the female herself selects it.

Habits of the caterpillar. In the only case observed by me, the caterpillars in exposed eggs hatched and moved away before those in underlying layers effected their escape; and it would seem as if this must need be the case. Not the slightest web of any kind is spun, not even in crawling from the walls of their prison, which are less than half demolished in their escape, many crawling out when only the crown has been bitten around, a little below the summit, and pushed back far enough to permit exit, only to return to its place by its elasticity after the passage of the prisoner. Nor do they eat their cast-off skins whether at the first or second moult, but leave them lying like a spread mat on the leaf just

where they walked out of them. There seems to be a very general negligence in this regard among social caterpillars, where the necessity for it would appear most urgent. They feed in close company always on the under surface of the leaves, moving up or down, generally down the plant, as they need fresh pasture, and leaving a desert behind them. Even when eggs to the number of a hundred are laid on one of the smaller terminal leaves, it is fully twenty-four, perhaps thirty-six hours after hatching before one of the caterpillars quits the leaf; the under surface of this single leaf suffices for all their wants for this time. They eat the parenchyma only, but not very cleanly, the leaves having everywhere little flecks of uneaten parenchyma, giving them a pitted appearance; this is in early life; they afterwards devour the leaf itself but still spin no web. They are very inactive, and cannot be roused to movement; at the most they will coil themselves into a circle and drop to the ground. The latest brood of larvae becomes lethargic soon after the second moult, but under favorable circumstances will continue feeding until October in the vicinity of Boston, and by the observations of Mr. Edwards sometimes arouse, pass another moult and again resume their lethargy. No lethargy is observable in the other broods according to Mr. Edwards. The caterpillars probably hibernate in any cranny they can find on the surface of the ground, as they leave the plant and wander more or less, but still to some degree in company. In this state and in this state only, apparently, the winter is passed. They must awake early in the spring, for sometimes at any rate they are full fed by the middle of May in Massachusetts.

Pupation. The larva attaches itself to any firm substance to undergo its final changes, but, under natural circumstances, apparently not to its food plant. In New England the chrysalis generally hangs nearly a fortnight, but Mr. Edwards has found it to range in various places, usually from six to thirteen days, sometimes prolonged to as many as thirty days.

General life history. In New England the insect is double-brooded, and passes the winter in the third and fourth larval stages. Farther south there are one or more broods interpolated between these two. Near Boston the first brood of butterflies appears about the middle of May*, though sometimes not until toward the 25th of the month; in central Connecticut I have found the species not uncommon, probably a week out, on May 15. As in the case with most species the first brood of which is made up from caterpillars wintering when half grown, it does not rapidly become common, not before the very end of the month, and sometimes not until the first week in June; rarely indeed is it abundant before the first of June, females are, I believe, never taken before the 21st of May,

* Dr. Merrill notes the capture of three specimens in Andover, Mass., April 27th; but this must be an error, through transposition of labels, or otherwise.

and fresh females may always be taken after the middle of June; it remains upon the wing often until the new brood makes its appearance, though in scanty numbers, and has sometimes quite disappeared by the end of the first week in July. The second brood is almost equally deliberate in its progressive advent. The males and females seem to appear at the same time, the earliest from July 12 to 18; both sexes continue to emerge without interruption from this time until the end of August, so that some observers have supposed there must be here a third brood; there is, however, no break whatever in the appearance of fresh females, and the unusual length of time during which they continue to emerge from the chrysalis seems to be due, *first*, to the individual difference of habit in hibernating caterpillars, spreading the first brood over an unusual period; *second*, to the sluggish habit of the insect; and *third*, possibly, to lethargy in mid-summer caterpillars, though this has not been observed in the least degree in the many broods raised in the south by Mr. Edwards. The butterfly usually disappears by the middle of September but I have taken specimens as late as October 13. The caterpillars stop eating and go into hibernation early in October.

In northern New England, as in Maine and the northern half, at least, of New Hampshire and Vermont, the periods are somewhat later, the first brood appearing in scanty numbers in the first week of June and rarely being common before the 10th, sometimes not until the middle of June. In the Catskills Mr. Edwards only found a few of the first brood out by June 18. Gosse reports it as appearing June 20 one year just over the Canadian border. The second brood also disappears earlier, none being seen by me one summer spent at Plymouth, New Hampshire, after the 20th of August.

The comparatively few notes I have from southern New England do not indicate, even as far as Nantucket, any noticeable difference from the seasons about Boston. But farther south there is undoubtedly, by Mr. Edwards's observations and the few others known, an intermediate brood. Mr. Edwards thinks there are four broods in West Virginia, but from the data given I do not think his reasons valid, considering the sluggish nature of the insect and its habits with us. Nor, from what I have observed of the behavior of the female and the condition of the ovaries in specimens dissected, do I think that the eggs are always laid soon after eclosion, but rather, that there is considerable difference in this respect in individuals. But however this may be, the earliest appearance of the imago in West Virginia is, according to Edwards, only the 18th of May. The butterfly was obtained in South Carolina by Mr. Atkinson, April 23, and Abbot, who seems to record only the first appearance of insects (when not bred), took it in Georgia on March 5. Boll found it as early as February in Texas and, according to Edwards, thinks there are five broods there, where it

flies until November. Edwards himself thinks there must be six or seven ; probably it would be quite impossible to tell.

An interesting feature in the history of this butterfly is the lethargy of the caterpillars already alluded to. Mr. Edwards finds that in West Virginia this peculiarity does not appear in the earlier broods, but only in the last two broods of larvae ; and while invariable in those of the last brood which winter, but sometimes become lethargic as early as the end of August, to judge from his account it also appears in the larvae of the preceding brood, some of which become lethargic in very warm weather, while the greater number proceed regularly, like the caterpillars of the preceding broods, to chrysalis. Our knowledge of their behavior in the north is entirely due to the accounts of Mr. Edwards, and are not founded on experiments conducted wholly there. Caterpillars from eggs laid at the end of July, and therefore of the second brood of butterflies, all became lethargic after the second moult, or about September 4 ; but two weeks later part of them resumed activity, fed a few days, passed another moult and then became lethargic again. These were placed in a cellar and remained without change through the winter. On another occasion eggs laid in the middle of August, in Coalburgh, were taken to the Catskills where they hatched on the 20th. After the second moult a portion, about 40 per cent, became lethargic, while the remainder continued their changes until the butterflies appeared (September 15-26) ; some of the chrysalids were kept in a cool place in Albany and gave out butterflies between October 21 and November 2. All this is of course not what happens freely in the Catskills under natural conditions, for it is safe to say that no butterflies emerge there as late as the middle of September. But it is interesting to note that about one half of the 40 per cent which became lethargic began to feed again about September 26, passed another moult and then resumed their lethargy. A third experiment showed that eggs laid in the Catskills at the end of June by butterflies of the first brood, and carried to West Virginia hatched there July 3, and most of them gave butterflies by the end of the month, but a portion even in this southern locality (about 5 per cent) became lethargic after the second moult, a thing which Mr. Edwards has not found to occur with West Virginian larvae at that season. This leads him to conclude that probably a portion of the caterpillars from the first brood of butterflies in the north become lethargic and continue so until the following spring, i. e., that in the north the species is partly monogoneutic and partly digoneutic, and that in the northernmost part of its range, to judge from the short season and dates of flight of the butterfly, it is monogoneutic only ; for instance, in southern Labrador and Anticosti the butterfly is not seen after June (though it has been taken on the upper Liard July 13 and at Edmonton July 15). This conclusion is in the highest degree probable, and the proportion of the caterpillars from the

first brood of butterflies which develop directly into the second as we pass from north southward would be a very interesting subject for investigation. Much might be told by a comparative estimate in given localities of the relative abundance of the butterflies of the first and second broods.

Habits. The butterfly is partial to flowers, especially such as grow in low, damp grounds, and when feeding it rests with its wings almost perfectly expanded, each raised at an angle of perhaps 5° - 10° . Mr. J. G. Jack observes that it sometimes persistently follows *Anosia plexippus*, alighting when it does and rising only when the larger insect takes to flight; and he asks if this can be for the sake of protection from some enemy; it is more likely that it is startled into flight by the movements of its gigantic ally. It is fond, too, of wet spots, as Mr. Edwards remarks, assembling in hundreds with other thirsty butterflies. Its flight is invariably slow, in keeping with its character, and for short distances only. It is in no way pugnacious as other butterflies, nor do the males pursue and tease the females to the same extent; but each seems rather intent upon a little more honey and willing rather to let alone and be let alone. All this is in entire keeping with its sluggish nature through life.

When resting quietly on a horizontal surface, the wings are closed, the front pair so fully concealed that the costal edges of all the wings are parallel and in the middle scarcely more than a millimetre apart. The body is raised at an angle of 60° with the surface, the outer portion of the inner margin of the hind wings resting on the ground; the antennae are extended on a line with the upraised body, and are very little arcuate when viewed laterally, the club curving slightly downward; they diverge at an angle of 95° and their tips are about 13.5 mm. apart.

Dr. C. S. Minot observed the position of the legs while the insect was at rest, and informs me that the femur of the front legs is directed upward and outward, with its distal extremity posterior to the base of the tarsi, which is a very unusual position; the tarsi of the middle legs are directed slightly forward; the tip of the abdomen rests upon the ground. Just before flying he observed the antennae quiver and the head turn in every direction as if to see if the coast were clear.

Dimorphism. The dimorphism of this species was first discovered by Mr. Edwards, who had previously distinguished for the first time between the two forms, regarding them as distinct species. His examinations have been very thorough and his account in the *Butterflies of North America* should be studied by any one wishing for information. With the prodigality of illustration which he there offers, and the detailed account of his experiments, nothing more is needed to make the matter perfectly clear. He shows conclusively that wherever the species is digoneutic, the earliest brood of the season differs from the later; and though it is certainly difficult sometimes to distinguish certain specimens of the first brood from

certain others which may occur in the later, and the differences as a whole are not so pronounced as in some other dimorphic species, there can be no question in the mind of anyone who has seen large series—the best test of the question—that the differences are valid. I express this opinion the more freely since before the dimorphism was known, I had refused to acknowledge the validity of specific distinction between *tharos* and *marcia*. There seems, however, in Mr. Edwards's opinion, some tendency to a premature disclosure of the spring form in the last month of the year, as occasionally specimens which must be referred to *marcia* have been taken very late in the season; this is a subject worth following up.

Experiments with cold. Mr. Edwards has made two sets of experiments: In the first instance on chrysalids from eggs laid by *P. t. morpheus* in West Virginia on August 15, but which were hatched and the larvae raised in the Catskills under protection until September 20, when the chrysalids were placed on ice for seven days and then retransported to West Virginia; they all gave *P. t. marcia* in October. The second experiment was from eggs of *P. t. marcia* laid in the Catskills, carried to West Virginia and raised there, and the chrysalids placed in an ice-chest at intervals of from ten minutes to nine hours after they were formed; these were removed after twenty days, and subsequently sixteen butterflies emerged—all *P. t. marcia* excepting two, the colors of which were suffused and so indeterminable.

Enemies. The caterpillar is attacked by the hymenopterous *Ichneumon instabilis*, which emerges from the chrysalis about a fortnight after suspension in the spring, biting off the anterior extremity to make its escape. Mr. Mead reports finding a green spider that had drawn his net about a cluster of the young larvae and “taken up his abode among them, no doubt finding it very convenient to have his prey within such easy reach.”

Desiderata. Notwithstanding, or rather by reason of, the thorough and extensive breeding experiments of Mr. Edwards more are needed, especially in New England, for New England lies in the direct path of the transition in this species from monogoneutism to digoneutism. In northernmost Maine, or on the southern shores of the mouth of the St. Lawrence, digoneutism is in all probability a rarity, and a knowledge of the comparative abundance of the two broods at such accessible spots as the towns on the northernmost line of the Intercolonial Railway—Point Metis, Rimouski, or even Cacoma, would be very desirable. If one could there raise under natural conditions of weather-exposure larvae from *P. t. marcia*, note their seasons and watch their behavior, we should, no doubt, learn much of interest. Similar observations for comparative purposes are needed at such places as the White Mountains, Plymouth, N. H., Boston, and New Haven or Nantucket. This and the relation of *P. batesii* to the present species are the points of greatest importance.

LIST OF ILLUSTRATIONS.—PHYCIODES THAROS.

General.	Imago.
Pl. 22, fig. 3. Distribution in North America.	Pl. 5, fig. 1. P. t. morpheus, male, both surfaces.
Egg.	3. P. t. morpheus, female, both surfaces.
Pl. 64, fig. 29. Cluster of eggs.	12: 1. P. t. morpheus, male, both surfaces.
31. Single egg, colored.	3. P. t. morpheus, female, both surfaces.
67: 15. Micropyle.	34: 1, 2. Male abdominal appendages.
Caterpillar.	39: 8. Neuration.
Pl. 72, fig. 6. Caterpillar at birth.	54: 2. Side view of head and appendages enlarged, with details of the structure of the legs.
75: 8. Front view of head.	61: 40. Papilla of tongue.
9. Dorsal view of caterpillar.	
79: 12-15. Front views of head in stages i, and iii-v.	
Chrysalis.	
Pl. 84, fig. 20. Dorsal view in outline.	
21, 22. Side views.	

PHYCIODES BATESII.—The tawny crescent.

<i>Eresia batesii</i> Reak., Proc. Ent. soc. Philad., v: 226-227 (1866).	sept., 171, pl. 47, fig. 5, [not p. 170, pl. 47, figs. 3, 4] (1833).
<i>Phyciodes batesii</i> Kirb., Syn. cat. lep., 172 (1871);—French, Butt. east. U. S., 180-181 (1886).	Figured in Glover, Ill. N. A. Lep., pl. O, fig. 4?, ined.
<i>Melitaea tharos</i> Boisd.-LeC., Lép. Amér.	[Not <i>Papilio tharos</i> Drury.]

The butterflies fold their wings of gold.

ELIZA COOK.—*Night*.

Imago (14: 5). Head covered with black and a few intermingled fulvous scales, mostly concealed by long, yellowish fulvous hairs among which, especially in the middle of the summit, are intermingled a few soft, brown ones; sides of the head covered with tawny and black scales, the black predominating above. Basal joint of palpi pale yellowish fulvous, slightly flecked with blackish, its inferior edge silvery white, especially in the basal half, fading as it approaches the tip, also narrowly edged with white where it hugs the eye; fringes yellowish fulvous more or less infuscated toward the tip, and on the upper edge mingled with black hairs; beneath pale yellowish; apical joint yellowish fulvous below, brownish above, delicately pale tipped. Antennae purplish black above, the basal fifth of each joint, excepting close to the base, interrupted with pure white, flecked a little with tawny exteriorly, and with fulvous interiorly; beneath pure white, the basal joints speckled slightly with black; club blackish, the white of the under surface extending a little way upon the basal joints. Tongue pale luteous, the apical portion infuscated.

Thorax covered above with olivaceous and brownish fulvous hairs; in front the hairs are more distinctly fulvous and upon the patagia greenish; beneath silvery or slightly bluish white. Fore legs faintly fulvous; other legs nearly uniform tawny fulvous, beneath silvery white; spines and spurs orange luteous; claws reddish luteous slightly infuscated at tip; pulvillus dusky.

Wings above fulvous, very heavily marked with blackish brown; *fore wings* so greatly obscured that they may more readily be described as blackish marked with fulvous; the cell is mostly fulvous, but the base is infuscated and limited by a convex edging, and crossing the middle of the cell is a heavy 8-shaped blackish spot, or two semicircles meeting by the middle of their arcs in the centre of the cell, and immediately below in the medio-submedian interspace is a similar spot most generally obscured and seldom more than faintly marked by paler edgings and centres; just

previous to the tip of the cell is a transverse, black line not infrequently merged in part in the large, black patch beyond the cell; the extreme base of the subcosto-median and upper median interspaces are usually marked with fulvous; in the outer half of the wing, besides a single submarginal distinct lunule in the upper median interspace, nearly the width of an interspace from the margin, there is between this and the darker base a double, transverse, sinuous series of fulvous spots, the inner ones tinged with ochraceous, the outer with cinnamoneous; the inner ones form a band of varying width, whose interior border passes from the middle of the outer two-thirds of the costal margin in a nearly straight line to a little before the middle of the upper median nervule; from here it passes in a rather deep curve, opening outward and dentated at the middle median nervule, to the middle of the outer two-thirds of the submedian nervule; this band is broken by the blackish nervules which are sometimes broadly margined on either side of the band; in the subcostal region the band is twice as broad as the interspaces and it is nearly as wide in the lower median interspace, but it is narrower above and below that; the outer row of spots are much smaller, more distinctly broken up into roundish spots, largest in the middle of the wing and diminishing regularly toward either border, their outer margin parallel to the outer border, their inner scarcely separated below the lowest subcostal nervule from the inner row of spots, but above diverging from it; outer margin faintly edged by a black line; fringe blackish fuscous, narrowly interrupted in the interspaces by white lunules which do not reach the base of the fringe, at the apex wholly whitish. *Hind wings* heavily blotched with black at the base, reaching in the cell as far as the middle, above it as far as the base of the first subcostal branch, below it as far as the base of the second median branch; but in this space sometimes occur fulvous spots showing that the blackish base is made up of agglomerated, transverse, black streaks; the apex of the cell is marked by a distinct, blackish arc, opening inward, its extremities united to a similar transverse line near the tip of the cell, and so enclosing between them a reniform, fulvous spot; the outer margin is very broadly bordered—to the depth of more than an interspace's width—with blackish brown, through the middle of which run connected series of very obscure, clouded, gray, slender lunules, becoming more distinct and paler next the inner margin; in the costo-subcostal and medio-submedian interspaces, the border extends nearly twice as far toward the base and its inner extremities are connected by a transverse, arcuate, powdery, black line parallel to the outer border (frequently absent between the middle subcostal and middle median nervules) and thus enclosing between it and the outer border, squarish, fulvous spots in the centres of each of which is a roundish, medium sized, black spot; a pale annulation in the medio-submedian interspace indicates a similar spot there; the veins are all blackish, excepting that sometimes the basal half of the lowest subcostal is fulvous; fringe dull whitish overlaid at extreme base by dusky brownish, and somewhat and narrowly infuscated at the nervule tips.

Beneath, pale greenish ochraceous; *fore wings* slightly suffused in part with fulvous clouds; crossing the cell a little beyond the middle is a broad, irregular, fulvous bar, seated on the median at its first divarication, with sinuous, darker, outer and inner borders, the outer occasionally deepening into black below; a similar, narrower spot marks the tip of the cell, just beyond which, depending from the costal margin, is a broad, blackish patch, reaching the upper median nervule, narrowing as it passes downward, generally twice as broad above as below, its exterior border a little concave, opening outward, and passing just within the base of the third superior subcostal nervule, its interior keeping a little outside the limits of the cell; in the upper median interspace is a small, blackish lunule as deep as broad and removed from the base of the interspace by its own width; occupying the base of the lower median interspace and crossing also the interspace below is a second large, black patch, made up of two spots, each quadrate and occupying the whole width of either interspace, but the lower one much the larger, surpassing the upper in either direction; within the latter, below the base of the lower median, is a small, black patch sometimes containing a fulvous spot, sometimes reduced to a transverse sinuous line; crossing the middle of the

outer two-thirds of the wing, its inner border following the outer margin of the inner mesial band of the upper surface is a band darker and more fulvous than the base, its outer margin ill-defined, supplanted by black next the upper margin, where its outer border reaches the base of the last subcostal nervule and below, in the lower median and medio-submedian interspaces and sometimes to a less extent in the upper median interspace, bordered exteriorly by large, blackish lunules which reach half way to the outer border; there is a submarginal series of connected, arcuate, fulvo-ferruginous lines, distant half an interspace's width from the outer margin; and as far again from the margin similar ones in the lowest subcostal and subcosto-median interspaces, sometimes obsolete. Fringe dirty white, the apical half except to a narrow extent in the middle of the interspaces brownish fuscous. *Hind wings* almost uniform in color, enlivened only by fulvous lines and dots; the short arcuate marks of the base of the wing appear narrowly and faintly beneath with delicate, fulvous tints; the middle of the wing is crossed by a slender and faint, irregular, crenulate stripe of fulvous, darkest and broadest next the costal margin; it starts from about the middle of the outer two-thirds of the costal margin, crosses to the middle of the basal four-fifths of the upper subcostal nervule in a slight curve opening basewards; from here in nearly a straight line sometimes crenulate, the curves opening outward, to the middle of the basal four-fifths of the upper median nervule; it crosses the median interspaces by curves a little further removed from the outer border and opening toward it; in the medio-submedian interspace it is a little nearer the outer border again and crenulate, the curves opening baseward, the curve nearest the inner border followed outwardly by another; midway between this mesial stripe and the submarginal, crenulate line is an arcuate or bent series of fulvous dots, the central ones becoming darker and sometimes nearly black, one in each of the interspaces which open on the outer border, that in the medio-submedian interspace slightly approaching the border; there is a submarginal crenulate line about one-third an interspace's width from the outer margin, that in the upper median interspace followed inwardly by a rather large, pale, sometimes whitish lunule; this is often edged interiorly with a fulvous line, but quite as often the outer border, as far as the dots and from the lower median nervule to the middle of the lower subcostal interspace, is washed with a paler or deeper fulvous tint; fringe pale, more or less infuscated, especially on the upper half of the wing, and next the tips of the nervules.

Abdomen above black, powdered with fulvous scales along the sides and toward the extremity; beneath white; the apical elongated scales fulvous. Clasp of the abdominal appendages of the male (34:9) tapering pretty regularly from base to tip, as viewed from the side, rather compressed, especially in the apical half, the whole of which is bent or curves downward; interior spine a little stouter than in *P. tharos*.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	16.25	17.6	19.	17.8		
antennae.....	8.30	9.	9.5	8.75		
hind tibiae and tarsi.....	5.	5.5	6.2	6.		
fore tibiae and tarsi.....	1.8	2.	2.	2.5		

In conversation with Dr. Boisduval of Paris, he expressed to me the opinion that this was the species from Cayenne, which he had been accustomed to consider the morphews of Herbst and the cocyta of Cramer.

Comparisons. The distinction between the upper surface of this species and that of the darker females of *P. tharos* is not very great; the intramesial bands in the present species are, however, heavier, and the brighter colors slightly paler. Beneath, and especially on the hind wings, *P. batesii* can better be compared with the paler, less discolored males of

P. tharos morpheus; the prevailing tint of the fore wings is the same pale greenish ochraceous that suffuses the hind wings, the orange or fulvous tints occurring mainly in the reverse of the inner intra-mesial band, and of the spot at the extremity of the cell, and in a transverse belt in the middle of the outer half of the wings; the black markings of the fore wings are much heavier and more distinct than they ever are in *P. tharos*. On the hind wings one uniform tint pervades the whole under surface; the transverse lines are very faint, obscurer than the palest *tharos*, and the large marginal patch in the middle of the wing, so conspicuous a feature on the wings of *tharos*, is entirely wanting.

Distribution (22:4). Our information concerning this butterfly is extremely meagre. Though recorded by Edwards from Ohio, it has rarely been found far from the Atlantic coast, and only in the Alleghanian fauna, unless the very doubtful reference by Couper of specimens from Anticosti and southern Labrador to this species is verified. (The identification was by Strecker.) In Virginia and West Virginia it is not common (Edwards), not uncommon in Pennsylvania (Reakirt), and has been found in southern New York (Graef), and about Albany and Schoharie (Lintner), as well as in Hamilton, Ont. (Johnson fide Fletcher). The only other states from which we have a record of its capture are Maryland (Edwards) and New Jersey (Aaron). Its home is therefore east of the Appalachians, from central New York to Virginia.

In New England I have taken it at the White Mountains.

Life history. Its earlier stages are totally unknown, but they will doubtless be found to agree very closely with those of *P. tharos*. I failed to obtain eggs from a female enclosed on *Aster novae angliae*. From the recorded times of flight of the imago, however, we may glean a little. In the south it appears toward the last of May, becoming abundant by the very end of the month. In Albany Co., N. Y., it appears by the last day of May, reaches its greatest abundance by the 7th of June, and was last seen by Mr. Lintner on the 22d of the same month. My captures at the White Mountains were on the 7th of June. No mention has been made of a second brood, though it doubtless occurs.

Desiderata. While the life history of this butterfly is unknown, it is not worth while to record other lack of information. It remains indeed to be proved, as suggested by Edwards, whether it is not simply a varietal form of *P. tharos marcia*, to which, rather than to *P. tharos morpheus*, its time of flight would consign it. This seems altogether probable, but only careful breeding will show the facts in the case.

LIST OF ILLUSTRATIONS.—*PHYCIODES BATESII*.

Imago.

Pl. 14, fig. 5. Male, both surfaces.

34: 9. Male abdominal appendages.

General.

Pl. 22, fig. 4. Distribution in North America.

CHARIDRYAS SCUDDER.

Charidryas Scudd., Syst. rev. amer. butt., 26
(1872).

Eresia pars Auctorum.

Phyciodes pars Auctorum.

Melitaea pars Auctorum.

Type.—*Melitaea nycteis* Doubl.

The butterflies come aping

Those fine thieves of ours,

And flutter round our rifled tops like tickled flowers with flowers.

LEIGH HUNT.—*Chorus of Flowers.*

Imago (54:3). Head rather large, rather sparsely furnished with long erect hairs. Front a little tumid, beneath broadly and rather largely protuberant, broader than high, somewhat narrower than the eye; upper border sloping a little toward the pit of the antennae, produced angularly and rather broadly between the antennae, where it is transversely and a little angularly arched; lower border well rounded and regular. Vertex rather large, considerably tumid, in its posterior half projecting considerably beyond the level of the eyes, not much broader than long, the sides a little concave, narrowing slightly, the posterior border gently rounded; the anterior border descending considerably and roundly to the antennal pit, produced quite strongly in front. Eyes moderately large and full, naked. Antennae inserted with their posterior border in the middle of the summit, in rather deep, distinct pits, separated by a space equal to nearly or quite the diameter of the second antennal joint, considerably longer than the abdomen, composed of from thirty-five to thirty-seven joints, of which thirteen or fourteen enter into the composition of the club; this is cylindrical, three times as broad as the stalk, from four to five times as long as broad, increasing very gradually in size, the middle portion uniform, then decreasing very gradually to a bluntly rounded apex, five or six joints entering into the diminution of size, the last joint very bluntly conical; beneath with a distinct median carina, extending upon the stalk. Palpi very long and moderately stout, more than twice as long as the longer diameter of the eye, directed forward and somewhat upward, the last joint scarcely two-fifths the length of the penultimate, and furnished with only a very few slightly spreading hairs in addition to its clothing of recumbent scales; while the other joints are amply fringed above and below with long, erect, forward reaching scales and hairs, all in a vertical plane.

Prothoracic lobes strongly appressed, especially exteriorly, where they are only half as long as interiorly, the upper surface well rounded, between three and four times as broad as high and about twice as high as long, the ends well rounded. Patagia moderately broad and quite long, more than three times as long as broad, the posterior lobe large and broad, narrowing but little but to a pointed tip, the inner border straight but bent not far from the apex, and the outer border concave at the same point, so that the end of the lobe turns outward a little.

Fore wings (39:9) three-fourths as long again as broad, the costal margin exactly as in Phyciodes, the upper part of the outer margin, as far as the lowest submedian nervule, nearly straight, scarcely convex, at about right angles with the costal margin; below, as far as the lowest median nervule, it is scarcely concave and bent inwardly at an angle of about 40°; below this a very little excised, the angle rounded off; inner margin scarcely concave. First superior subcostal nervule arising shortly before the apex of the cell; the second as far beyond the apex of the cell as from the third; this slightly further from the fourth than from the second; the fourth twice as far from the apex of the cell as from the outer margin; second inferior subcostal nervule arising fully one-third way down the outer margin of the cell; the cell fully two-fifths the length of the wing and two and a half times longer than broad. Last median nervule connected at a short distance from its origin with the vein closing the cell.

Hind wings with the costal margin as in Phyciodes, the outer border rather broadly

rounded but more fully in the ♂ than in the ♀; inner border somewhat expanded but not very abruptly next the base, beyond straight as far as the tip of the internal nervure, beyond which it is somewhat excised and a little concave, the angle rounded off. Precoastal nervure forked above, the inner fork very short, the outer directed strongly outward, as long as the main stem. Second subcostal nervule originating but very little beyond the first; cell open.

Fore legs short, cylindrical, in the male with but a slight fringe of long, scarcely spreading hairs on the outer side; tibiae scarcely two-fifths the length of the hind tibiae; tarsi less than half (♂) or fully (♀) as long as the tibiae, either with very faint indications of divisions into joints, and especially of one close to the apex, the tip armed with two or three straight spines as long as the width of the joint (♂); or, consisting of five joints, the first rather longer than the rest taken together, the second half as long as those beyond taken together, and the others decreasing toward the tip; all but the last furnished at the apex beneath with a pair of small, but long and slender spines, all but the first of which are immediately followed on the next joint by several bristle-like spines, which seem to strengthen them; the second, third and fourth joints have also a pair of minute spines in the middle of the lower portion of either side, and the first a subapical larger spine in the middle beneath; the space between the spines naked (♀). Middle tibiae slightly shorter than the hind tibiae, furnished on either side of the under surface with a row of not very long but very slender and rather infrequent, somewhat spreading spines, the apical ones developed to rather long and very slender spurs; also with a row of shorter and less frequent spines on the upper limit of the inner side and a few scattered ones on the outer side. First joint of tarsi nearly as long as the rest together, the second nearly as long as the third and fourth combined, and scarcely longer than the fifth, the fourth shortest, and the third slightly shorter than the fifth; furnished beneath with four rows of short, slender spines, the spines of the middle rows on the basal half of the first joint alternating, the apical spines of each joint considerably longer than the others. Claws small, moderately stout, strongly falcate, ending in a fine point; paronychial double, the superior lobe just shorter than the claw, similarly curved, very slender and tapering, on its under edge coarsely pectinate; inferior lobe short, broad, stout; pulvillus small, quadrate, transverse, the anterior edge rounded.

Abdomen slender, the upper organ of the terminal male appendages with the semblance of a hook in two united pieces which project slightly downward at the hinder extremity of the centrum. Claspers stout, tumid, of pretty irregular form but subquadrate, broadly rounded below, abruptly rounded above, bearing at the tip two curving spines, one above the other, the lower incurved a little, the upper recurved strongly; besides, arising just within the base of the latter and lying in a horizontal plane, a stouter backward curving spine.

Egg. Subcylindrical, flat at base, largest in the middle, much higher than broad, narrowing very slightly on apical half, below regularly rounded, above truncate, the upper half with rather frequent vertical ribs which fade out below; the surface is smooth. (See the note under the description of the species *C. nycteis*, below.)

Caterpillar at birth. Head rounded, each hemisphere independently arched above. Body cylindrical, the segments somewhat moniliform, each with a transverse row of raised points (the position of which has not been stated) each bearing a microscopically spiculiferous bristle. (From descriptions of Saunders, Edwards and Gruber.)

Mature caterpillar. Head well rounded, the sides broadly rounded, broadest a little above the middle, the hemispheres slightly tumid at summit, very slightly protuberant externally, the suture between them a little depressed, the front a little appressed, a little deeper beneath than above, covered above and on the sides with distant small wartlets emitting slender, not very long hairs; triangle flat, half as high again as broad, reaching somewhat more than half way up the front; second joint of antennae nearly as long as broad, the third scarcely slenderer at base and as large at tip as the second, but twice as long as broad, the tip rounded, the fourth joint very minute. Ocelli, six in number, five in rather a broad curve, its convexity forward

and scarcely downward, the middle three nearly in contact, the lowest separated from the fourth by nearly its own diameter, and the uppermost from the second by a greater distance; the sixth forms with the first and fourth a right angle, but is a little nearer the former; the third, fourth and fifth are very prominent, the second less so and the first and sixth but very little raised above the surface. Labrum rather large, prominent, half as broad again as long, the middle of the front a little and not deeply excised; mandibles not very large nor stout, moderately broad, the edge straight, with a few rather large, not deep triangular teeth; maxillary palpi with the second joint nearly as long as broad, the third not much smaller and but little longer than broad, the fourth conical and conspicuous. Spinneret minute, very short and slender.

Body cylindrical, equal, furnished with longitudinal rows of coarse, tubercular spines, one to a segment in each row; they are heavy, scarcely tapering, pretty long, blunt at tip, the sides irregularly supplied with numerous papillae or abbreviated spinules, each armed with a long, straight, rather stout needle, scarcely tapering, bluntly pointed, directed upward so that those of opposite sides are at an angle of from 45° - 90° with each other. The spines are arranged in the following manner: a dorsal row on the first to eighth abdominal segments, the eighth with two; a laterodorsal row on the second and third thoracic and the first to seventh abdominal segments; a lateral row on the same segments, a suprastigmatal row on the second and third thoracic and on all the abdominal segments, and on the first to seventh abdominal segments an infrastigmatal row; besides these there is a row of linear tubercles bearing needles like the others, situated on the thoracic and first to seventh abdominal segments, at the base of the prolegs when these occur, two upon a segment, and on the apodal segments one each. The front edge of the first thoracic segment is thickly beset with forward curving, long, spinous hairs. Legs small, and moderately slender, tapering, the claws slender, scarcely tapering, heeled strongly at base, bent just beyond and scarcely curved.

Chrysalis. Viewed from above the prothorax and the parts in front taper a little and regularly, the ocellar prominences not greatly pronounced, bluntly rounded at the outer anterior angle, the front of the head a little convex, the curve slighter in the middle. Viewed from the side the front and summit of the head and of the ocellar prominences are bent at very slightly more than a right angle, slightly rounded at the angle; the inferior face of the prominences, which is on a line with that of the front of the head between them, is in direct continuation of the slight curve of the inferior face of the body, and the anterior face in almost direct continuation of that of the thorax. Lower surface of anterior half of body nearly straight longitudinally. Thorax considerably arched, highest and angular slightly in advance of the middle of the posterior half of the mesothorax, where it is raised to a very low rounded prominence, with a somewhat abrupt posterior face, the apex rounded. Basal wing tubercle pyramidal, triquetral, not high, the apex blunt, the superior edge running up as a slight ridge nearly half way to the laterodorsal tubercles of the mesothorax, the posterior edge forming a long, blunt ridge which is scarcely elevated to form a supernumerary tubercle. Prothorax without tubercles. Abdomen considerably and regularly arched longitudinally; a laterodorsal series of conical, bluntly tipped tubercles of medium size on the middle of the meso- and metathorax and the second to seventh abdominal segments, slenderer and directed slightly backward on the fifth to seventh segments; those of the metathorax and second abdominal segment are smaller than the others, which are nearly equal among themselves. On the abdomen there is also a dorsal series of warts on the second to seventh segments, each exactly similar to the laterodorsal warts of the same segments, and placed a little in advance of the middle; the third and fourth segments have also a suprastigmatal series of two small, conical warts a little in advance of the middle. Inferior base of cremaster bounded laterally by coarse, stout, not greatly elevated, curving walls, approximated considerably at the anterior end, and each terminating in a moderately large, nearly recumbent, rounded tubercle; cremaster proper, viewed from above, laterally tuberculated at the base, not very long, rather slender, tapering, bluntly rounded, considerably longer than broad,

rudely and narrowly channelled longitudinally; viewed from the side nearly twice as long as broad, tuberculate, equal, curving considerably, the apical field of anal hooklets nearly circular. Hooklets not very long, pretty slender, the stem nearly straight and enlarging very slightly, the crook very strongly bent, considerably enlarged and especially broadened.

This genus is peculiar to North America east of the Rocky Mountains, extending from the Saskatchewan, the Great Lakes and the St. Lawrence to the Gulf of Mexico.* Two species are found within the limits mentioned, a northern and southern, meeting on the western prairies; only the northern occurs in New England, and has been found throughout its extent at distant and various places.

The butterflies are rather under the medium size and their general pattern resembles that of *Phyciodes*; the markings of the upper surface are rather heavier, and beneath, the spots and dashes on the hind wings are more frequently inclined to silvery; the dots of the submarginal row, the repetition of those on the upper surface, are delicately ocellated. These butterflies have rather a feeble flight, "are fond of alighting in the vicinity of water and have a decided partiality for the banks of rivers and small streams" (Doubleday).

The northern species is single brooded in the northern part of its range and partly single, partly double brooded in the southern; from the slight information we possess of the seasons and transformations of the southern species, it is probable that it follows closely the southern peculiarities of the northern species. They winter as larvae rather more than half grown, hang from nine to fifteen days in the chrysalis and appear in the early part of the hot season. The eggs are soon laid, and in clusters. In early life the caterpillars live in company, after hibernation or in later life singly, on different *Asterineae* and *Heliantheae*, especially the latter, with an apparent preference for *Helianthus* and *Actinomeris*; when young they feed upon the parenchyma of the leaf only.

The eggs are cylindrical, squarely truncate at the base and provided over at least a portion of the sides with about sixteen or seventeen slight vertical ribs. The caterpillars are cylindrical, furnished with a dorsal row, and, on each side, four lateral rows of thorny tubercular spines, of which one row on either side lies below the spiracles. The chrysalids are not very angular, with the dorsal face of the thorax and abdomen well arched and a considerable, but not sharp constriction between; the ocellar prominences are slightly pronounced and the abdomen is furnished with several rows of small conical tubercles. They are pale yellow brown marked with blackish streaks.

* It may be that some species occur also in Central America.

EXCURSUS XX. — THE THREE PIONEER STUDENTS OF BUTTERFLIES IN THIS COUNTRY.

Hast thou been in the woods with the honey-bee?
 Hast thou been with the lamb in the pastures free?
 With the hare thro' the copses and dingles wild?
 With the butterfly over the heath, fair child?

HEMANS.—*Child's Return from the Woodlan* .

FORTUNATELY for the study of butterflies in this country the earlier students were those who devoted themselves very largely to the natural history of these insects rather than to their systematic or descriptive study. It was indeed a natural and healthy result of the poverty of external resources in earlier times; and I have thought that it would not be devoid of interest to present a few facts concerning the life and industry of three of these earlier naturalists, who worked to such good purpose and accomplished so much, under circumstances that would now seem very forbidding.

A unique figure, perhaps the most striking in the early development of natural history in America, is that of a man of whom we know almost absolutely nothing excepting what he accomplished. With one exception, all our knowledge of his personality comes through tradition. No life of him has ever been written, excepting a brief notice by Swainson in the *Bibliography of Zoology*, to which Mr. G. Brown Goode has kindly called my attention. It is not known when or where he was born, or when he died; scarcely where he lived, or to what nationality he belonged. Even the town where he worked no longer exists. His name alone remains, and though we have access to not a little of his writing in his own round hand, his signature cannot be discovered.

John Abbot was presumably an Englishman, as the name is English, and he is said by Sir J. E. Smith to have begun his career by the study of the transformations of British insects. When not far from thirty years old, and probably about 1790, he was engaged by three or four of the leading entomologists of England to go out to North America for the purpose of collecting insects for their cabinets. After visiting several places in different parts of the Union, he determined to settle in the "Province of Georgia," as Swainson calls it. Here he lived for nearly twenty years in Scriven County, as I am informed by several persons through the kindness of Dr. Oemler, of Wilmington Island, in that State, returning to England apparently not far from 1810, where he was living about 1840, at an age "probably above eighty." It is rumored in Georgia that he owned land there, and all that can be learned of him comes from persons beyond middle life in that State, who remember hearing their parents speak of him. Col. Charles C. Jones, the Georgia historian, informs me through Dr. Oemler that "while he remained in

Georgia, in the prosecution of his scientific labors, his head-quarters were at Jacksonborough, then the county seat of Scriven County. Here his work on the Lepidoptera of Georgia was largely prepared. All traces of this old town have now passed away." It is supposed that he also employed himself as a school-master in this place, but this is purely traditional, and his occasional bungling, not to say ungrammatical, sentences rather indicate a lack of schooling on his own part. What we certainly know regarding him is that he entered into relations with John Francillon, a silversmith in the Strand, London, who had a famous collection of insects and an extensive entomological correspondence. Francillon undertook to supply subscribers with drawings of insects and plants by Abbot, as well as with specimens, the latter of which, says Swainson, "were certainly the finest that have ever been transmitted as articles of commerce to this country; they were always sent home expanded, even the most minute; and he was so watchful and indefatigable in his researches, that he contrived to breed nearly the whole of the Lepidoptera. His general price for a box-full was sixpence each specimen: which was certainly not too much, considering the beauty and high perfection of all the individuals. Abbot, however, was not a mere collector. Every moment of time he could possibly devote from his field researches was employed in making finished drawings of the larva, pupa, and perfect insect of every lepidopterous species, as well as of the plant upon which it fed. These drawings are so beautifully chaste and wonderfully correct, that they were coveted by every one." It would appear from a note in Kirby and Spence's *Introduction to Entomology* (5th ed., iii: 148) that "the ingenious Mr. Abbot" also knew the art of inflating caterpillar skins, and dealt in them through Francillon. There still exist in various places, principally in the British Museum, but also at Oxford, Paris and Zurich, and in this country at Boston, large series of his drawings of insects and plants. Those in the British Museum are arranged in seventeen stout quarto volumes, bound in red morocco; each volume has a printed title page and is dated 1792 to 1804, the dates no doubt between which they were purchased for the Museum through Francillon from Abbot, and which probably indicated the period of his greatest activity in America. In Boston two similar volumes exist, one of which was presented by Dr. Gray of the British Museum, to Dr. Gray the botanist of Cambridge, and by him to the Natural History Society, where it may now be seen. The other volume is a collection, perhaps the only considerable one which has never passed out of this country, which was purchased by the Society from Dr. Oemler, of Georgia, who inherited it from his father.*

In the sixteenth volume of the British Museum series, there is a

* Mr. Oemler of Savannah and Mr. in Abbot's notes as sending him specimens "LeCompte" [LeConte] are both mentioned found in their gardens to rear and paint.

miniature portrait let into the title page, which, tradition says, was painted by Abbot himself, and indeed it bears every mark of this, though there is no memorandum to this effect within the volume. This portrait is published herewith from a faithful copy taken for me by the late Mr. George Willis. With its peculiar physiognomy and strait dress it adds considerably to our interest in the original; there seems to be not a little humor in the quaint features and figure, and the spare form hardly gives the figure of robust health which the face would indicate. Abbot probably returned to England about 1810 at an age of perhaps fifty, and our portrait was doubtless painted at about this time, certainly before he left America, since it represents him in the thinnest of southern costume. There were old persons living in Georgia up to 1885, but since deceased, who knew him, but apparently none now remain.

Abbot's work was by no means on Lepidoptera alone, as any of the series of his drawings will show. Dr. Hagen, in speaking of the volume in the British Museum containing the Neuroptera, says that all the details are given with the greatest care, and that in almost all cases the species can be identified. The same is the case with most of the drawings of Lepidoptera, though there is a mark of carelessness in some of the figures of early stages which is not found in others; this is no doubt due to the fact that so many applied for these drawings, "both in Europe and America, that he found it expedient to employ one or two assistants, whose copies he retouched, and thus finished they generally pass as his own. To an experienced eye, however, the originals of the master are readily distinguished." Many of these drawings, especially those of the British Museum, we have copied upon our plates, as much for their special interest in connection with Abbot's work as for their representation of forms which are here described.

It would hardly appear that he paid more attention to Lepidoptera than to other insects. Yet in the Oemler collection alone there are one hundred and thirty-three plates of Lepidoptera, nearly every one of which figures a species distinct from the others, and ninety-four of which are accompanied by the early stages. Twenty-two of these are insects figured in Abbot and Smith's work, but the figures of the early stages are in no case identical; they represent the same insect but in different attitudes. Of these one hundred and thirty-three plates, thirty-four are concerned with the butterflies. The drawings of butterflies in the British Museum are contained in the sixth and sixteenth volumes, the former comprising the perfect insects only, the latter the early stages as well, and in this latter series thirty-six species are figured, while the two Boston collections contain figures of the early stages of all but two of the species represented in the British Museum volume. Swainson states that a series of one hundred and three subjects of Lepidoptera, including none published before,

was executed for him "with the intention of forming two additional volumes to those edited by Dr. Smith, but the design is now abandoned."

Each set of drawings furnished by Abbot seems to have been accompanied by more or less manuscript, in which the life history of the insect is given in brief form, with the food plant of the caterpillar and the times of the change of the caterpillars to chrysalids, and of chrysalids to butterflies, which shows that Abbot must have been an exceptionally industrious rearer of insects. Indeed the transformations of not a few of our butterflies are even now known only through the observations and illustrations of Abbot. Dr. Boisduval was good enough to present me with three series of manuscript notes entitled "Notes to the Drawings of Insects," all written in Abbot's own hand, and comprising twenty-seven foolscap pages, rather closely written, and describing the changes of two hundred and one species; of these thirty-eight are butterflies. These, unfortunately, are referred to only by number and by an English name, which Abbot himself applied, apparently, to every insect of which he furnished drawings, such as the "reed butterfly," the "ringed butterfly," the "lesser dingy skipper," etc., though he occasionally makes use of such names as the "autumnal ajax," "Papilio antiopa," etc., showing his familiarity to a certain extent with Linnean names. As the names and drawings are in some instances kept together, the manuscript of those in which they are not connected is still of use. It appears that nearly all the Georgian butterflies were observed and painted by Abbot, and that of about sixty species which he raised he distributed illustrations and notes of the early stages to some of his correspondents.

As is well known by all aurelians, one considerable collection of Abbot's drawings was published by Sir James Edward Smith in two sumptuous folio volumes, but these comprise, as far as the butterflies are concerned, only twenty-four species. This work made an epoch in the history of entomology in this country. Besides this Abbot published nothing. The article credited to him in Hagen's Bibliography was by a Rev. Mr. Abbot, who wrote from England in November, 1798, when Abbot was in this country.

A second work which marked an important advance in our knowledge of the transformations of the butterflies of North America was the unfinished volume by Boisduval and Le Conte, entitled *Histoire générale et iconographie des Lépidoptères et des chenilles de l'Amérique septentrionale*, published in Paris more than half a century ago. Twenty-six parts appeared between 1829 and 1834, interrupted after the issue of the eighth part (pp. 1-80; pl. 1-24) by the revolution of 1830, and resumed in 1833. How large a part was due directly to the labors of Major Le Conte himself, whose family has borne a conspicuous part in the scientific history

of this country, will probably never be known. The descriptive portion is doubtless the work of Boisduval, and he unquestionably incorporated in the work many observations and illustrations of the earlier stages by Abbot; but many of the illustrations are certainly the work of Le Conte,* who was only less industrious than Abbot in rearing insects because his scientific interests extended over a wider field. The internal proof of this is tolerably clear. Abbot's drawings were many times duplicated by him, but a not inconsiderable proportion of the early stages figured in the work of Boisduval and Le Conte are not to be found in the collections of Abbot's drawings either in London or Boston; so many indeed that it seems highly probable that they are the work of another hand. If we credit these or the larger part of them to Le Conte, we shall probably be near the truth. Moreover, some of the drawings that Boisduval showed me in Paris were contained in a little oblong folio volume, on sheets broader than high (27x16.5 cm.), instead of on ordinary large folio sheets as in all the other collections; now the drawings of Major Le Conte, recently sold with the library of his son, Dr. John Le Conte, mounted on paper of variable form, were many of them of a shape and size very similar to that of the oblong folio mentioned above; so that these drawings in Boisduval's hands were perhaps those of Le Conte himself, and from these in many cases the drawings in Boisduval and Le Conte's work, and some which I have reproduced in this work, were taken. Dr. Le Conte has himself told me that his father had complained of his treatment by Boisduval.

Major Le Conte's tastes were many-sided, but his special studies, those which were the passion of his life, were in natural history. He was named for his father, John Eatton Le Conte, and was born near Shrewsbury, N. J., February 22, 1784. He graduated at Columbia College and then joined his brother Lewis in Georgia, and with the latter devoted himself to his favorite pursuits. Most of his life, however, he resided in New York. He was captain, afterward brevet-major, in the corps of topographical engineers from 1818 to 1831. Before he entered the engineer corps, he published a catalogue of the plants of New York City, in the journal edited by Dr. David Hosack, and in subsequent years, during his connection with the army and afterwards, he published special studies on *Utricularia*, *Gratiola*, *Ruellia*, *Tillandsia*, *Viola* and *Pancreaticum*, as well as on our native grape-vines, tobacco and pecan-nut. He published also a variety of papers on mammals, reptiles, batrachians and crustacea, mostly of a systematic character, and collected a vast amount of original material for the natural history of our insects. Coleoptera, however, may be said to have been his specialty, particularly in the latter part of his career, though he published only four papers upon them, and

*He is credited by Boisduval with only the drawings of the imago of *Speyeria idalia*.

mainly upon a single family, Histeridae. He not only amassed a considerable collection, but he left behind, as already stated, a most extensive series of water-color illustrations of our native insects and plants (as well as of reptiles and other vertebrates) made with his own hands. He was in the habit of visiting his brother in Georgia every winter, up to a short time before his death, which occurred at Philadelphia, November 21, 1860. According to Professor Le Conte Stevens's family records, Major Le Conte was a somewhat corpulent man, "about five feet six inches in height, with rather dark complexion, blue eyes and aquiline nose. In disposition he was usually sociable and sufficiently communicative, but occasionally reticent and secluded, strong in his affections and aversions, and much beloved by his relatives whom he visited in Georgia. . . . For a number of years he was a member of the Episcopal Church, but he subsequently became a Roman Catholic, and in this faith he died." The portrait which we publish in facsimile bears out this description; it is carefully copied from an oil miniature in the possession of the family, by the kind permission of the widow of the late Dr. John L. Le Conte, to whom, also, I am indebted for the autograph which accompanies it.

The third person whose life will here be briefly sketched was an inhabitant of New England, and on account of his remarkable labors became the pioneer of economic entomology in this country. It was entirely through his familiarity with the early stages of insects that he gained this preeminence, and his work, the publication of which (excepting in the paltry emolument which it brought to its author) reflects great credit upon the state of Massachusetts, still remains, and will long remain an acknowledged classic.

Thaddeus William Harris was born in Dorchester, Mass., November 12, 1795, and died January 16, 1856 at Cambridge. He was therefore but a few years the junior of Major Le Conte. His father was at first librarian of Harvard College, afterwards a clergyman in the town where his son was born; while his son, beginning his career as a physician, quitted it in 1831 for the librarianship which his father had held before him. But it was during his residence at Milton as a country physician that the greater part of his field observations were made. The subsequent years were largely employed in working up the material then obtained, which, although working in one of the largest libraries of the time, he was obliged to do under circumstances of the utmost difficulty. Not only were works that he required not procurable, excepting on rare occasions, but the solitariness of his position is clearly indicated in a letter written to Mr. Doubleday of England, in which he congratulates the latter that he is not "compelled to pursue science as it were by stealth, and to feel all the time, while so employed, that you are exposing yourself, if discovered, to

the ridicule, perhaps, at least to the contempt, of those who cannot perceive in such pursuits any practical and useful results." The accuracy and care with which his observations were made are revealed by his ample note-books, now in the possession of the Boston Society of Natural History, and in their elaboration in his classic work upon the insects of New England injurious to vegetation. This work, which forms his principal claim to our attention, has passed three editions. It was prepared under appointment as Commissioner of the State of Massachusetts; but all that he ever received from the state for this immense labor was one hundred and seventy-five dollars. As will be seen in the life published by Colonel Higginson, prefixed to the volume of his Entomological Correspondence, Harris had formed an idea of publishing a local insect fauna which should include only the common species of the vicinity of Boston. This was done on the prompting of many friends, and many fragments of different parts of it are extant in the notes and manuscript preserved carefully by the Natural History Society. *Faunula Bostoniensis* was the title he had intended for it, and among the more complete fragments was one which embraced all the butterflies of the vicinity of Boston known to him. This fragment, on the publication subsequent to his death, of the third edition of his treatise on New England insects, I urged should be incorporated into this work, as he had himself previously attempted to do, and be accompanied by illustrations of the principal forms; this was done,* and further notes upon the early stages of butterflies will be found covering a dozen pages of the appendix to his "Entomological correspondence." This was the first tolerably complete descriptive list of the butterflies of any district in North America ever attempted. Doubtless the notes upon the early stages would have been very much more extensive, had not the duties of his position in the library of the University almost absolutely prevented any proper attention to field work. The very existence of his cabinet, with the vigilant care which must be taken for its protection from insect pests, in the open drawers which alone his straightened circumstances allowed him,† must have consumed every moment that he could spare from his official duties. But the labors which he undertook and the amount he accomplished under such disadvantages have been the foundation stones of entomological science in this country. Painstaking and laborious to the last degree in all he undertook, his accuracy has never been questioned and his principal work with its simple, direct style can never be superseded. He was the Gilbert White of New England. A tall, spare man, subject, at least in latter life, to nervous headaches, his face showed somewhat the mark of physical fatigue. But the portrait which accompanies his "Entomological correspondence," and which through the kindness of the Natural History Society

* They are republished in this work.

† He had a family of twelve children.

we are permitted to reproduce, shows in its expression a vigor and persistency which was the key to his industry and success.

* Besides the life of Dr. Harris by Col. T. W. Higginson to which we have alluded, another by his son, Edward Doubleday Harris (named for the English lepidopterist), should be consulted (Proc. Mass. hist. soc., xix); and for further details of the Le Conte family, the life of Major Le Conte's son, Dr. John Lawrence Le Conte (Biogr. memoirs Nat. acad. sc., ii, and Trans. Am. ent. soc., xi). The notice of Abbot, substantially as given above, was first published in the Canadian entomologist for 1888.

CHARIDRYAS NYCTEIS.—The silver crescent.

[The silver crescent (Scudder); silver crescent butterfly (Maynard).]

Melitaea nycteis Doubl., Gen. diurn. Lep., pl. 23, fig. 3 (1847);—Edw., Proc. Acad. nat. sc. Philad., 1861, 161-162 (1861);—Morr., Syn. Lep. N. Amer., 325-325 (1862);—Lintn., Rep. state cab. nat. hist. N. Y., xxiii: 158-159, pl. 8, fig. 14 (1872);—Middl., Rep. ins. Ill., x: 83-84 (1881);—Grub., Jen. zeitschr. naturw., xvii: 478, pl. 8, figs. 30-32 (1884); Pap., iv: 90, pl. 3, figs. 30-32 (1884);—Mayn., Butt. N. E., 28-29, pl. 4, figs. 33, 33a (1886).

Melitaea (Phyciodes) nycteis Doubl.-He-wits., Gen. diurn. Lep., i: 181 (1848).

Eresia nycteis Feld., Neues Lep., 49 (1861).

Phyciodes nycteis Kirb., Syn. cat. Lep., 173 (1871);—Riley, Proc. Amer. ass. adv. sc.,

xxiii, B: 108-112 (1875);—Edw., Can. ent., xi: 101-105 (1879);—Coq., Rep. ins. Ill., x: 165 (1881);—Fern., Butt. Me., 48-49 (1884);—French, Butt. east. U. S., 172-174, fig. 50 (1886).

Charidryas nycteis Scudd., Syst. rev. Amer. butt., 26 (1872).

Melitaea oenone Scudd., Proc. Ess. inst., iii: 166-167 (1863).

Melitaea harrisii Edw., Can. ent., ii: 163 (1870);—Saund., Can. ent. iv: 161-163 (1872).

Figured by Glover, Ill., N. A. Lep., pl. 25, fig. 2; pl. H, fig. 9 ?, ined.

[Not *Melitaea harrisii* Scudd.]

Yes, the Summer, the radiant Summer's the fairest,
For greenwoods and mountains, for meadows and bowers,
For waters, and fruits, and for flowers the rarest,
And for bright shining butterflies, lovely as flowers.

MARY HOWITT.—*Summer*.

Imago (5: 6). Head covered with yellowish fulvous and dusky hairs, changing in front and especially toward the tongue, to whitish; lower three-fourths of the hinder edge of the eye broadly bordered with snow white. Basal and second joint of palpi white, with a white fringe, mingled with a few dusky hairs, the upper part of the apical half of the middle joint, including its whole apex, and the apical joint, brownish fulvous with a few black scales, the extreme tip of the latter white; whole upper border of inner side and the whole apical joint heavily obscured with blackish, the middle joint fulvous apically. Antennae above blackish brown, each joint annulated, the basal one but partially, with white; beneath white, the inside of the joints, especially those of the apical half mostly castaneous; club black, the outer under surface white, the inner under surface dusky orange, the apical four or five joints or less, dull, deep orange beneath and partially so above; basal third of tongue luteous, the remainder blackish fuscous; papillae (61: 41) situated at the extreme tip, on the outer edge of the under surface, moderately crowded, each appressed, cylindrical, a little enlarged in the middle, as long as half the width of the tongue, three or four times as long as broad, ending in a moderately large cup with sharp rim, from the centre of which springs a slender, cylindrical, scarcely tapering, blunt tipped filament as long as the narrowest width of the papilla.

Thorax covered with olivaceo-fulvous hairs above, more decidedly fulvous on the prothorax and patagia; beneath snow white, the fore legs the same, faintly tinged

externally with luteous; other femora white, the apex above suffused with pale orange, tibiae and tarsi pale orange, whitish externally; spines reddish yellow, duskier toward the tip of the tarsi; spurs slightly paler; claws fusco-rubrous.

Wings above pale orange fulvous, inclining to yellow, generally deepest in tint on the outer third of the hind wings. Basal three-fifths of the costal border of the *fore wings* broadly margined with black which is continued downward at its extremity, at the tip of the costal nervure, in a broad, transverse belt, whose interior border is scarcely removed from the extremity of the cell and which terminates suddenly at the middle median nervure, its apical margin often covering the basal third of the same; within this belt are the following markings: at the base of the cell is an oblong oval, longitudinal, annular black spot (enclosing, more or less distinctly, a fulvous pupil), its outer extremity near the centre of the cell, its basal half generally obscured by the griminess of the base; below the median nervure and resting upon it is an elongated, wedge-shaped spot, its apex at the base of the wing, its base just within the first divarication of the median nervure and crossing half the interspace, also enclosing a similarly shaped, sometimes obsolete fulvous streak; seated upon its termination a chain of three black, roundish links, nearly equal in size, but frequently obscured or partially merged together, cross the cell; the extremity of the cell itself is marked by a fulvous streak, bordered outside by the broad mesial demi-band and inside by a rather narrow edging of black; just beneath this the lower half of the wing is crossed by a black band of irregular width, the smaller portion, sometimes broken from the other, consisting of a black patch at the base of the lower median interspace, excepting the extreme base and sometimes extending half way across the medio-submedian interspace, the other a broad patch seated just within the middle of the submedian nervure and extending half or fully across the medio-submedian interspace; the inner border, to the submedian nervure, as far as this point and sometimes to the outer border, blackish. Sometimes all the markings mentioned are nearly all blended into a mass of black, enclosing a few indistinct, irregular, fulvous patches. The outer border is so broadly bordered with black as to leave, between it and the markings just described, only a broad, transverse, fulvous belt, extending from just beneath the black costal edge to the internal nervure, broken by the principal black subcostal nervules, and generally by the other nervules which are often blackish fuscous, at least on the outer half of the band; at the costal margin the band has the width of one of the median interspaces; it widens below this, the outer border being directed downward and a little more outward than the exterior margin of the mesial demi-band, and sweeping around in a rather uniform curve to the internal nervure, at about the distance of an interspace from the outer margin; within this, from the upper median nervule downward, is often seen a rather broad black streak, vaguely formed of lunules opening outward, parallel to the neighboring black border and occasionally wholly, often partially, confluent with it, enclosing small, pale fulvous spots in the interspaces, which continue upward above the median nervure, as far as the costal margin, in a curving row, parallel to the outer border of small, whitish spots or dots, occasionally obsolete; in the upper median interspace is a small, submarginal, often partially obsolete, pale fulvous lunule, and a second smaller one is sometimes seen in the lower median interspace; fringe white, interrupted rather broadly with black at the nervure tips, especially at the lower subcostal nervule. *Hind wings* with all the veins blackish, the inner border yellowish, but excepting that, and a broad, dirty, yellowish patch at the base of the costal margin, nearly the whole basal half of the wings, as far as a line which runs from the costal nervure at the middle of the costal border in a very slight stiff curve, often irregular and interrupted, passing the upper median interspace at its very base and reaching the middle of the submedian nervure, is obscured with blackish, enclosing a few irregular fulvous patches; within this, in clearer specimens, a few definite markings can be distinguished; a black reniform annular spot, the inner half of which marks the extremity of the cell; the tip of the cell marked by an equilateral fulvous triangle, just within which a coarse, blurred chain of two or three black links crosses the cell, within which again the cell is fulvous, but greatly begrimed with blackish

scales. The outer border of the wing is broadly margined with black, varying in width in different individuals from half an interspace, where its inner limit is a wavy line, to fully an interspace, where the limit is a straight line, the latter more common; frequently it is narrowest in the lower subcostal and subcosto-median interspaces; on the costal border, the black outer margin extends toward the base, filling the costo-subcostal and sometimes the upper half of the upper subcostal interspace nearly as far as the basal black field, its interior limit continued as a narrow, arcuate, or broader, ill-defined band, parallel to the outer border, reaching the submedian nervure in the middle of its outer half, beyond which the fulvous tints are apt to be deeper than they are within it, especially in the female: scarcely separated from the black edging of the outer border is an arcuate series of six roundish black spots, sometimes, especially the slightly larger ones of the median interspace, enclosing yellowish white pupils, the largest, half the width of an interspace. In the middle of the black edging of the outer border is often seen a nearly obsolete series of faint, linear, pale yellow lunules, fulvous in the medio-submedian interspace, seldom appearing in the upper half of the wing; fringe white or yellowish white, interrupted broadly but not abruptly with black at the nervure tips.

Beneath: *Fore wings* very faint, pale yellowish orange, the mesial demi-band depending from the costal border reappearing beneath in blackish brown: an irregular annular subreniform spot crosses the middle of the outer two-thirds of the cell and the extremity of the same is marked by an obpyriform annular spot whose interior half follows the apical nervules; faint dusky indications of the transverse patch seated on the middle of the inner border appear beneath, and the outer border is margined as broadly with blackish brown; the markings connected with the border are repeated beneath and, in addition, the round, pale spots on the upper half of the wing are narrowly encircled with black; the margin has a narrow edging (about one-quarter the width of an interspace) of orange, itself delicately edged on both sides with black and followed interiorly by a series of dull silvery lunules, as wide as the interspaces, pretty large in the two subcostal interspaces at the apex of the wing and in the upper median interspace; elsewhere nearly linear and occasionally absent, especially in the lower subcostal and subcosto-median interspaces: fringe as on the upper surface. *Hind wings* pale buff, occasionally with a slight greenish tinge, the veins chocolate brown; at the extreme base of the costal border a dull, silvery spot edged externally with chocolate brown; beyond this is a transverse series of large, dull, silvery spots, each edged externally and internally with chocolate brown; the first is in the costo-marginal interspace; the next directly beneath it in the costo-subcostal, distant from the base of the interspace by half its own width; this by another irregular spot which occupies nearly the whole of the cell, excepting the extreme base and encloses, or is divided in two by, a large double, sometimes confluent, buff spot, seated on the first divarication of the median nervure and nearly crossing the cell; beneath the same divarication, is another roundish spot in the medio-submedian interspace; sometimes a small spot occurs beside and a little beyond it, in the succeeding interspace; beyond this series the wing is traversed, especially on the upper half, by transverse, irregular, partially blended, ill-defined, chocolate brown stripes, the outer limit of which passes from about the middle of the costal border to a little beyond the middle of the submedian nervure, crossing the upper median interspace only a little beyond its base; a distinct arcuate line of deeply curving, continuous, linear, chocolate brown lunules, opening inwards, crosses the wing subparallel to the outer margin at three-fifths the distance from the base; the very broad, chocolate brown bordering of the outer margin having a scarcely waved interior outline is separated from this by less than the width of an interspace, but it is sometimes entirely wanting above the middle of the lower subcostal interspace or below the submedian nervure; sometimes the interior border only is indicated and usually the interspaces in the area referred to are devoid of dusky scales beyond the interior ill-defined margin of the outer bordering; at a little less than two interspaces' distance from the outer border, a slightly sinuous series of six large, white-pupilled, blackish spots, the lower sometimes double and approaching

the border, usually edged with orange; the margin of the wing is ornamented as on the fore wings and is followed in a similar way by dull, silvery lunules of varying sizes, the highest (as high as broad) being those of the costo-subcostal, upper subcostal and upper median interspaces, those of the lower subcostal and lower median being less than half as large and the others nearly or quite linear or obsolete; fringe as on the upper surface.

Abdomen blackish above, with a few scattered fulvous scales, especially at the apices of the segments, and on the sides more than above; beneath white, often faintly tinged with buff. Appendages of male (34:5, 6) with clasps scarcely longer than broad, upper edge emarginate interiorly; apical spines of nearly equal length, about half as long as the clasp; the lower is bent downward and backward and a little inward, at its middle commencing to curve pretty strongly inward and a little upward; upper spine strongly recurved from its base along the upper edge of the clasp, in an almost exactly opposite direction to the apical half of the interior spine, which does not, like the apical spines, delicately taper to a point.

Measurements in millimetres. Length of tongue, 7 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	17.5	20.5	21.5	22.	24.	25.5
antennae.....	8.75	10.	10.25	10.5	11.	11.2
hind tibiae and tarsi.....	5.25	6.1	6.6	6.5	6.7	7.5
fore tibiae and tarsi.....	2.	2.1	2.4	2.4	2.8	2.9

Described from 32 specimens, of which 15 were ♂, 11 ♀.

Comparisons. Specimens from West Virginia appear to be almost uniformly smaller than the few I have seen from New England, and still more so than western examples. The species, which at first sight considerably resembles *Phyciodes tharos*, can be distinguished from that species, *above*, by the general color of the surface, which is not quite so deep, and is apt to be still paler in the middle than on the outer third of the hind wings; by the much larger size and frequently pupilled condition of the submarginal series of round black spots on the hind wings; by the greater community of the black markings on the basal half of the same, rendering that part of the wing almost completely black; and by the conspicuous alternation of black and white in the fringe; *beneath*, by the paleness of the brighter tints of the fore wings; the color of the hind wings, which is buff instead of ochraceous; the whole character of the marginal markings as detailed in the descriptions; the much larger and more ornamented character of the submarginal series of round black spots on the hind wings; the quite different nature of the markings on the basal half of the hind wings; the presence of decided though dull silvery spots on the hind wings, a part of which appear in some extreme individuals of *P. tharos* as a sort of silvery gray; and finally by a much less extended range of variation. The present is also a larger species.

Secondary sexual peculiarities. In exceedingly scanty numbers I have found at the base of the median interspaces on the upper surface of the fore wings, in the male and not in the female, scales which have the apical margin entire and well rounded, and which I therefore take to be androconia (46:15), though I have not found others in the Melitaeidi; they are considerably more than twice as long as broad, subequal, with very broadly convex sides, and produced and rounded basal lobes; they differ from the ordinary scales only in being untoothed, and are about .125 mm. long.

Egg (64:32). Half as high again as broad, provided above with sixteen to seventeen vertical ribs, .06 mm. apart, fading out below; color very pale green. Height, .67 mm.; breadth, .45 mm.

This description was taken from specimens removed from the body of the parent. Mr. Edwards describes the lower third of the egg as smooth, the middle third marked by hexagonal pits or cells, and the upper third by vertical ribs.

Caterpillar. *First stage.* Head dark greenish brown, nearly black. Body dull, pale yellowish, with a yellowish patch above on terminal segment, the raised parts

slightly darker and their bristles pale brown and moderately long. Prolegs color of body; legs pale, semitransparent. Length, 1.5-2.5 mm. (after Saunders).

Second stage. Head (79:16) black and shining, with a few short, pale brownish hairs. Body above brownish black, dotted and spotted with greenish, with a pale greenish white stigmatal band, having a broken brownish line running through it; the tubercles generally black, encircled at base and varied at tip with greenish, and the bristles black, but in the stigmatal band often wholly greenish; under surface of body paler and greenish. Legs tipped with black; prolegs pale, semitransparent. The bristles are partly spiculiferous, partly smooth, and then swollen at base. Length, 4.5-6 mm. (after Saunders, Edwards and Gruber).

The stage described as "after the first moult" by Saunders was evidently taken during the first stage, as the fleshy tubercles were not yet developed.

Third stage (79:17). Head black, covered more or less with black hairs. Body black brown above, greenish brown below, the tubercles longer than in preceding stage, with broad bases and with the bristles black. Length, 6 mm. (after Edwards).

Fourth stage (79:18). Head rather cordate, broadest above, appressed, piceous, the surface covered with many black hairs of unequal length. Body black brown or reddish brown above, with a few gray dots, smoky brown beneath; there is sometimes a stigmatal, broken yellow stripe or testaceous band, dotted with whitish, but the color here is usually dull green, and the yellow wanting; a few blue dots arranged in two transverse lines behind the dorsal series of tubercles. The tubercles themselves are stout at base, long, black or rufous, the tubercles closely crowded and piceous; stigmata blackish. Legs black; prolegs rufous. Length, 8.5-20 mm. (after Edwards and Lintner).

Fifth stage (75:15). Head (79:19) shining piceous, covered with infrequent, rather long, blackish, more or less reddish brown, tapering hairs, seated on minute black warts; basal joint of antennae very dark plumbeous, remainder black. Ocelli black; mouth parts black. Body above rich velvety black; a stigmatal, dull orange band extending the whole length of the body; from the lower base of the suprastigmatal row of spines to midway between the infrastigmatal row and that below it, streaked, between the spiracles, with dark purplish; beneath olivaceous brown; the whole body abundantly dotted with minute, transversely oval or circular, whitish spots, each giving rise to a very delicate, rather short, blackish hair; anterior spinous hairs of the first thoracic segment black, spines dark livid brown or blackish, those of the lowest row upon the base of the prolegs black; the needles of all the spines black, excepting on the infrastigmatal row, where they are yellowish brown. Spiracles black, encircled with pale. Legs black, claws reddish; prolegs brownish yellow. Length, 23 mm.; breadth of body, 4 mm.; length of spines, 1.5 mm.; breadth of head, 2.65 mm.

Chrysalis (84:19). Upper surface of head, thorax and first abdominal segment white, very prettily, profusely and irregularly mottled, streaked and speckled with reddish fuscous, occasionally changing to black, the heavier markings of the mesonotum arranged to some extent around the laterodorsal tubercles; the tips of the ocellar prominences are united above by a transverse black streak; ocellar ribbon edged above with black. Lower surface of head and linear appendages much like the thorax; the antennae are rather distantly annulated with white, and marked basally with blackish; the principal joints of the legs are marked with white, edged basally with black; the apical half of the tongue is infuscated. Wings dull white, profusely marked with creasings of reddish fuscous, giving them a brownish hue, and heavily streaked with broad, longitudinal black dashes, especially at the posterior border, the basal half of the costal border, and the extremity of the cell; several similar collected streaks next the posterior border, at one-third the distance from the superior and inferior borders; there is also a submarginal row of white dots; there is a heavy transverse streak at the basal wing tubercle, and at the supernumerary tubercle a curving, oblique streak, which infringes on the outer border of the metanotum. Abdomen pale yellowish, faintly but rather abundantly marked with yellowish brown, and slightly with black;

there are suprastigmatal and infrastigmatal rows of black dots situated on the anterior parts of the fifth to eighth segments; and above the former, on all the abdominal segments, is a slender, interrupted, blackish fuscous line; there is a pair of subventral black lines, and the sides are marked more or less with blackish fuscous dots. The tubercles are of the color of the adjoining parts, excepting that the dorsal and laterodorsal ones of the meso- and metathorax and first and second abdominal segments are marked at the base anteriorly with black, sometimes tinged with reddish. Cremaster very heavily edged with black. Length, 12.5 mm.; width at ocellar prominences, 2.3 mm.; at basal wing prominences, 5 mm.; at metathorax, 4 mm.; height of thorax, 4.5 mm.; of abdomen, 5 mm.

"The chrysalis of this species varies much. Some are light-colored, nearly white, with delicate blackish spots and fine streaks of brown over the surface; others are almost wholly black, while others again are between the two extremes" (Edwards).

Distribution (22:5). This species, properly a member of the Alleghanian fauna, is widely spread. Northward it occurs as far as Ha Ha Bay on the Saguenay (Saunders), Quebec "rare" (Bowles), Montreal (Caulfield), London, Ontario "not common" (Saunders), and even to Sudbury and to Nepigon, north of Lake Superior (Fletcher). Southward it extends along the Atlantic coast to Virginia (Reakirt), West Virginia and even North Carolina (Edwards); otherwise east of the Mississippi it has not been recorded further south than the Ohio River. It is far more abundant on the western prairies than in the Atlantic states, Mr. Allen finding it the most abundant species seen during a whole summer's collecting in Iowa. Westward it extends even to Edmonton on the north Saskatchewan (Geddes), to Nebraska (Carpenter), Kansas, where it is common and New Mexico (Snow), as well as to Colorado (Reakirt, Mead), Arizona (Edwards) and Texas north of 30° (Aaron, Mead); but in the elevated regions of these latter localities it varies so much from the type that Edwards considers it a distinct variety (*C. n. drusus*), distinguished by the excess of black over fulvous on the upper side.

In New England it is a very rare insect although Mr. Lintner has found it in some abundance near Albany, New York and in the Adirondacks. In Maine single specimens have been taken at Lewiston (Sprague) and Norway (Verrill, Smith), and it is also recorded from Orono (Fernald) and Portland "rare" (Lyman). In New Hampshire it has twice been taken on the Glen road at the very base of the White Mountains (Sanborn, Morrison) and once at Walpole (Smith). In Massachusetts it has been also occasionally taken,—Sutton (Smith), Blanford (Dimmock), Holyoke (Johnson), Lenox (Edwards) and Williamstown (Scudder); and in Connecticut at Farmington (Norton). Most of these New England localities, it will be noticed, are upon elevated ground. They comprise all known captures.

Haunts. In Colorado Mr. Mead found the butterflies only at about an elevation of 7,500 feet in the mountains, and they were rare. In Iowa where they are extremely abundant they were found by Mr. Allen on the *Symphoricarpos* which grows in prairie hollows; others were seen in damp,

shady spots, or the edge of streams flowing between steep, wooded slopes, and in ravines among low, thick growing timber. In New York Mr. Lintner found them flying with *Phyciodes tharos*.

Oviposition. The eggs are laid upon the under surface of a leaf of the food plant in clusters of from a few to about a hundred, "side by side and in regular rows" (Edwards), and the duration of this stage is from nine to fourteen days.

Food plant. The caterpillar feeds upon various Compositae, such as Asters, *Aster* (*Doellingeria*) *umbellatus* Torr. and Gray, *Rudbeckia laciniata* Linn., *Helianthus divaricatus* Linn., *Actinomeris squarrosa* Nutt. and *Verbesina helianthoides* Nutt. Sunflower and *Actinomeris* appear to be its favorite food.

Habits of the caterpillar. While examining one of the eggs of this species under the microscope, writes Mr. Saunders (Can. ent., iv : 161-2).

One of the mandibles of the enclosed larva was thrust through the egg-shell near the upper surface, and soon after the other appeared near by in the same manner, and after some effort these were made to meet, and then shortly a small opening made, which admitted of the head being partly thrust through, when the larva soon began to eat the egg around, with the view of removing the top. The thickened striae of the egg were not ruptured without much effort. . . . After tearing through two or three . . . the larva rests awhile from its efforts, and then begins afresh. . . . After one hour and thirty-five minutes had been spent in these efforts (including frequent rests), the top was gnawed nearly around, when the head was pushed up, and the lid tilted over. The larva now rested for about ten minutes, although there was no obstacle to its egress, and then commenced to extricate itself, by first bending its head backwards and forwards, and stretching upwards. [After three or four segments were withdrawn], working its body from side to side with the head upwards, and alternately working it round with the head downwards, grasping with its jaws at adjoining eggs, or anything else within reach, the remaining segments were speedily withdrawn, the whole operation not occupying more than five or six minutes.

When young they are gregarious and feed only on the parenchyma of the leaf, leaving the transparent membrane; and "when alarmed by a sudden motion of the plant, they immediately loosen their hold to the leaf and suffer themselves to fall to the ground, with their bodies bent in a circle. After lying motionless for a few minutes, if not again disturbed, they . . . arouse themselves and travel rapidly away to some place of concealment" (Lintner). At a later stage "they consume the whole surface of the leaf, which becomes very filthy from the excrementitious matter mixing with the juices of the leaf; but the caterpillars emerge from the mire as clean as a mole from under the ground" (Edwards). They spin a slight web on a leaf when they wish to moult, but do not construct one for concealment or protection at any other time, hibernating without that aid. The only statement that they live within a web is by Miss Middleton (Rep. nox. ins. Ill., x : 82-83) who says that this species "like the phaeton, forms a web." Saunders, Lintner, Riley and Edwards say nothing of the sort.

Life history. In the northern part of its range, i. e., in the region

embraced within the limits of this work and west of it, this insect is single-brooded, and hibernates when partly grown, doubtless in crevices afforded by objects lying on the ground; on emerging in the spring the caterpillar, which then feeds singly, grows slowly until June, when, after spending ten to fifteen days in the chrysalis state, it emerges as a butterfly; the earliest males appear about the middle of June, but do not become abundant until the females emerge, generally early in July; the latter are not common until the middle of the month, when, or a little later, they begin to predominate, and the males to be worn and dull; the females continue at least throughout July.

The eggs must be laid at once, for there is no record of the capture of the female after July and specimens enclosed by Mr. Saunders laid eggs before July 5; so, too, caterpillars were found in their second stage on August 20 by Mr. Lintner near Albany. The caterpillars moult two or three times before hibernating, the earliest ones becoming dormant by the middle of July (Saunders) while others are delayed until the end of August (Lintner). The condition of captured butterflies, however, shows that these all are to be referred to a single brood.

Further south, the history is a much more complicated one; we have only the observations of Messrs. Edwards and Riley to guide us, besides our knowledge (from very scattered observations) of their habits at the north. These all lead us to conclude that the insect in the latitude of West Virginia and Missouri is partially single and partially double brooded, and not as Mr. Edwards supposes (perhaps from unpublished observations) single, double and triple brooded. This curious condition is brought about by the fact that a portion of the caterpillars born from the first brood of butterflies pass through their stages in an ordinary manner and produce in time a second brood the same season; while another portion lagging at first a little behind their brethren, often from the same batch of eggs, finally pass, at the hibernating age, into a state of lethargy while it is still midsummer or even by the end of June. They even assume at this early period the livery they wear through the winter, which is of a russet color, according to Mr. Edwards, and not black like their brethren of the same age who are not laggards.

Of ninety-two larvae from one lot of eggs laid May 28 [writes Mr. Edwards] and all which passed their first moult about June 18, fifty-six proceeded to second moult about June 21, and third moult about June 26, and so on to chrysalis. But thirty-six lingered after the first moult, and thirty-two of them assumed the russet hibernating coat... at second moult, while the remaining four came up then in black coats, like the larger part of the brood, and slowly proceeded to chrysalis, which they reached many days after the others. These four seemed to have had a tendency to join the hibernators, which was somehow counteracted, but they proceeded with a hesitancy at every stage till they reached chrysalis. [Of the thirty-two all continued lethargic through the season, and some survived the winter.]

Of the earliest hatched caterpillars of the season about one-third be-

come dormant at the hibernating stage; while later on, with those which hatch in midsummer, two-thirds become dormant at the same stage while the others complete their transformations the same year. This circumstance, apparently, has led Mr. Edwards to think there are three broods in the south. But his own account of the retardation in the development of some of those which do not actually become dormant, together with the great inequality in the development of the hibernating larvae in the spring as shown by Mr. Edwards (Can. ent. xi: 104-5), lead one to believe that the phenomenon may best be explained and made accordant with what we know of the same insect at the north by looking on the butterfly as partly single, partly double brooded in this part of its range.

Postures. Having seen but a single specimen in open air it is impossible for me to describe the flight of the butterflies. Observations on a captive showed that when at rest upon a perpendicular surface, the wings are closely shut, the basal half of their costal edges confluent; the antennae, raised at a slight angle above the surface of rest, are parallel at the base—for about seven or eight joints—and then diverge at an angle of 35° - 40° , their tips being about 5-6 mm. apart; excepting this, and that the club is slightly upturned, they are straight. On a horizontal surface the attitude differs only in that the antennae are held nearly perpendicular.

Experiments with cold. Mr. W. H. Edwards placed several chrysalids in an ice box for from twelve to eighteen days. Most of them were killed by it, but three gave butterflies unaltered in color or pattern.

Desiderata. It is evident from what has preceded that we need most of all careful and repeated observations at the north of the comparative behavior of the earliest and latest born caterpillars during the same season and again under untrammelled conditions in the spring. The eggs have never been found laid naturally. Do the larvae under no conditions live in company under a web? What is the range of variation as to the stage when the caterpillars hibernate? Why should the female appear so much later than the male? At what latitude does the second annual brood first make its appearance? What is the character of the flight of the butterfly? No parasites have been discovered. What is the southern range of the species west of the Atlantic states?

LIST OF ILLUSTRATIONS.—*CHARIDRYAS NYCTEIS*.

<i>General.</i>		<i>Imago.</i>	
Pl. 22, fig. 5.	Distribution in North America.	Pl. 5, fig. 6.	Female, both surfaces.
<i>Egg.</i>		34: 5, 6.	Male abdominal appendages.
Pl. 64, fig. 32.	Outline.	39: 9.	Neuration.
<i>Caterpillar.</i>		46: 15.	Androconium.
Pl. 75, fig. 12.	Mature caterpillar.	54: 3.	Side view of head and appendages enlarged, with details of the structure of the legs.
15.	Caterpillar about to pupate.	61: 41.	Papilla of tongue.
79: 16-19.	Front views of head, stages ii-v.		
<i>Chrysalis.</i>			
Pl. 84, fig. 19.	Side view.		

CINCLIDIA HÜBNER.

Cinclidia Hübn., Verz. bek. schmett., 29
(1816).
Melitaea (pars) Auctorum.

Mellicta Billb., Enum. ins., 77 (1820).
Limnaecia Scudd., Syst. rev. Amer. butt.,
26 (1872).

Type.—*Papilio phoebe* Schiff.

O butterfly on whose light wings
The golden summer sunshine clings;

O moon and sun that beam and burn,—
Keep safe my Love till I return!

GILDER.—*Sweet Wild Roses*.

Imago (54 : 4). Head large, furnished with rather long, sparse, erect hairs. Front slightly tumid, scarcely at all protuberant below, barely surpassing the front of the eyes, a little broader than high, not nearly so broad as the eyes, the upper border roundly excavated in front and sloping considerably toward the antennal pits; lower border sharply rounded. Vertex pretty large, a little tumid, but also slightly flattened above, especially posteriorly, just reaching the level of the summit of the eyes, scarcely, if at all, broader than long, the sides narrowing but little, the posterior border scarcely rounder, the anterior sloping considerably toward the antennal pits. Eyes rather large, moderately full, naked. Antennae inserted with the middle of their posterior half in the middle of the summit, in deep, spacious, distinct, scarcely connected pits, separated by a space equal to the diameter of the summit of the second antennal joint; considerably longer than the abdomen, composed of about thirty-three joints, of which the last twelve or thirteen form the club, which is strongly depressed, fully four times as broad as the stalk, about three and a half times longer than broad, oblong ovate, increasing rather rapidly at the base, well rounded at tip, four or five joints entering into the diminution of size, with no noticeable carina beneath. Palpi long, and moderately stout, scarcely twice as long as the eye, directed upward and considerably forward, the last joint nearly half as long as the penultimate, clothed with recumbent scales and a very few slightly raised hairs, while the other joints are furnished, both above and below, with a very long and rather dense fringe of long, erect, forward reaching hairs and scales, all in a vertical plane.

Prothoracic lobes rather small, strongly appressed, scarcely more so exteriorly than interiorly, the upper surface well rounded, the ends well rounded and nearly equal, more than twice as high as long and rather more than three times as broad as high. Patagia moderately broad and rather long, scarcely three times as long as broad, the posterior lobe curving a little outward, moderately broad, tapering and terminating in a bluntly pointed tip.

Fore wings (39 : 3) two-thirds as long again (♂) or nearly twice as long (♀) as broad; costal margin slightly convex on the basal fifth, most prominent at about one-fourth the distance from the base; beyond nearly straight, the angle rounded off; outer border considerably and pretty regularly convex above the upper median nervule, below that nearly straight, in general having a direction at an angle of about 60° with the apical half of the costal border; inner border straight, the angle rounded off. First superior subcostal nervule arising shortly before the apex of the cell; the second at one-quarter the distance from the base of the first to the outer border; the third not so far from the second as that is from the apex of the cell; the fourth at fully two-thirds the distance from the base of the first to the outer border, and as far from the third as the second is from the first; second inferior subcostal nervule arising at about a third way down the cell; this is about two-fifths the length of the wing and two and a half times longer than broad. Last median nervule connected at a short distance from its base with the vein closing the cell.

Hind wings with the costal border considerably and roundly expanded next the

base, beyond nearly straight, slightly convex; the outer margin scarcely crenulate, well and pretty regularly rounded, more regularly in the ♂ than in the ♀, the margin being fuller next the completely rounded upper angle, while it is comparatively fuller in the subcostal region in the ♀; the lower angle is abrupt but rounded off, and the inner margin a little expanded, but not abruptly next the base, slightly convex on the basal half, nearly straight and a very little excised on the apical half. Precostal nerve directed straight upward, but not far from its tip bent abruptly and rather strongly outward. Second subcostal nervule originating but a little beyond the first; cell open.

Fore legs short, the members tumid, in the male thinly fringed with long, but little raised hairs on the outer side; tibiae half (♂) or a very little less than half (♀) the length of the hind tibiae; tarsi one-half the length of the tibiae (♂) or of the same length (♀), either slender and with but slight indications of divisions and unarmed (♂); or distinctly composed of five joints, of which the first is tumid and somewhat longer than the others collectively, they slender and diminishing regularly in size; all but the last furnished beneath with long and slender apical spines on a naked field, the last two pair followed on the next joint by several bristle-like spines as supporters; the first and second joints have also a central subapical spine beneath (♀). Middle tibiae scarcely longer than the hind pair, armed on either side beneath with a row of very long and slender, not very frequent, somewhat spreading spines, the apical ones developed as not very long, but slender, tapering spurs. First joint of tarsi scarcely shorter than the others combined, the last scarcely shorter than the second, the second, third and fourth diminishing in regular ratio; furnished beneath with four rows of pretty long and very slender, frequent spines, the last of each joint slightly longer than the others. Claws small, delicate, strongly falcate, finely pointed; paronychial double, the anterior lobe nearly as long as the claws, not greatly curved, tapering considerably, the apex bluntly pointed, coarsely pectinate beneath; posterior lobe short, moderately slender, curved inward. Pulvillus not large, not much broader than long, well rounded.

Abdominal appendages of the male having the clasps stout, tumid, irregularly and broadly oval, much longer than broad, bearing at the tip two strongly curving, flattened spines, appearing to originate from a separate piece soldered to the upper extremity of the clasp; the lower of these spines curves inward, the upper forward; in addition, arising from near the base of the latter is a similar spine curving over inward strongly.

Egg. Barrel shaped, tapering above more than below, the broadest part below the middle; the summit broad, saucer shaped, only slightly depressed, smooth and glistening; the sides with numerous vertical ribs which are only slightly elevated and which extend from the bottom of the egg to the well defined edge of the saucer where they abruptly end, more or less interrupted below the middle by the numerous, but slight, rounded or polygonal depressions with which the egg is here studded.

Caterpillar at birth. From notes taken by me, but which I am unable to verify, I think the hairs of this stage of *Cinclidia* are arranged in laterodorsal, lateral and stigmatal series, the lateral with two, the others with one to a segment; but they are somewhat differently disposed on the thoracic and abdominal segments. There is no dorsal series, as in the later stages.

Mature caterpillar. Head subquadrate but broadly rounded, broadest in the upper part of the ocellar field, rather broader than high, the sides scarcely tapering upwards, the summit broadly and but little produced exteriorly, considerably but broadly and roundly excised above along the suture; the front appressed, almost flat, the sutures a little impressed, the head slightly the deepest just below the middle, covered above and on the sides, though scarcely on the front, with infrequent, moderately large and broad, conical tubercles, emitting no hairs, but a few pretty long, curving hairs appear on the front as elsewhere, arising from exceedingly minute wartlets. Antennae with the second joint exceedingly short, the third not greatly narrower, more than half as long again as broad, the fourth minute. Ocelli six in number, five

of them arranged in a moderately strong curve, its convexity forward, the third and fourth, counting from above, almost attingent, the third and second, the fourth and fifth, and the first and second removed from each other by increasing distances, the latter by a space equal to the diameter of one of them; the sixth, behind the others, forming a right angle with the first and a point between the third and fourth, and a little nearer the former. Labrum moderately large and long, well rounded, either lateral half a little tumid, the front border slightly and roundly excised in the middle. Mandibles small, slender, not broad, the edge armed with five or six rather short, triangular, slender denticles. Maxillary palpi with the basal joint bearing an inner two-jointed palp and an outer, longer, three-jointed one, the penultimate joint of each being slightly longer than broad, rounded at the tip, the last joint minute. Spinneret short and slender, tapering slightly.

Body cylindrical or very slightly depressed, tapering forward a little on the anterior thoracic segments, the rest of the body nearly equal, armed with numerous spines arranged one to a segment in a series, in longitudinal rows; they are not very long, conical, tapering to a blunt point, thickly studded with minute tubercles, scarcely longer than broad, one at the tip slightly longer than the others, each bearing a long, tapering, needle-like thorn, the lower ones longest and nearly or quite as long as the spine itself, the lower ones spreading nearly horizontally, the upper inclined upward at an angle of about 45° with the spine. They are arranged as follows: a dorsal row placed anteriorly, upon the first to eighth abdominal segments, the latter with two, one placed posteriorly; a laterodorsal series, placed a little in advance of the middle of the segment, upon the second and third thoracic and the first to eighth abdominal segments; a laterostigmatal series, placed anteriorly on the second and third thoracic and first to ninth abdominal segments, the latter with two, one being placed posteriorly; an infrastigmatal series placed centrally, on the first and second thoracic and first to eighth abdominal segments; and a ventro-stigmatal series, placed centrally, on the thoracic and the first to seventh abdominal segments, the second to sixth abdominal segments having two each; the first segment bears anteriorly a transverse row of spines, which correspond to those upon the second, excepting that the laterodorsal ones have become subdorsal and are very small, the laterostigmatal ones very small and transversely double, a supplementary one being crowded between the normal and the laterodorsal spine. Body with a few scattered, very short and exceedingly delicate hairs. Spiracles rather small, short obovate, about half as long again as broad. Legs short, small, rather slender, appressed, tapering and the claws small, pretty strongly heeled at the base, beyond very slender, nearly equal, very gently curved; prolegs rather short, not very stout, tapering, the hooklets twenty-five to thirty in number, very slender and delicate, pretty strongly curved, not crowded, arranged in a double row around a little more than half of the inner portion of a circle.

Chrysalis. Viewed from above, the prothorax and the parts in front taper a little, but not regularly, being broken at the base of the ocellar prominences by a distinct lateral swelling; the ocellar prominences are not greatly pronounced, the outer sides being parallel, the enlarged anterior portion small and regularly swollen, the laterally angulated tip sometimes minutely notched, the broad front of the head separating their bases straight or very slightly convex. Viewed from the side, the lowest anterior faces of the ocellar prominences are bent rather sharply at very slightly more than a right angle, the head more rounded and its front advanced slightly in front of the inferior face of the prominences; inferior face of the prominences nearly in continuation with the inferior face of the body; anterior face at an angle of 150° with the anterior part of the thorax. Longitudinally the lower surface of the body, as far as near the wing tips is nearly straight, very slightly and broadly sinuous. Thorax with a pretty high, longitudinal curve, not quite regular, being scarcely bent at the middle of the anterior half of the mesothorax, and a little in advance of the posterior half of the same, raised to a slight, low and very broad conical prominence, with an equal slope on all sides. Wing tubercles much as in *Charidryas*, the supernumerary one perhaps a little more elevated, and the superior ridge of the basal one not quite so long,

curving. Prothorax with a transverse row of four minute warts next the anterior edge. Abdomen considerably and regularly arched; a laterodorsal series of pretty regular, conical, bluntly tipped tubercles of medium size, on the middle of the meso- and metathorax and the first to ninth abdominal segments, that of the last two segments being only low, blunt warts, the last a little below the line; those of the mesothorax are a little larger than the others, and those of the first abdominal segment a little smaller; with these exceptions they are equal; on the abdomen there is also a dorsal row of similar tubercles on the anterior portion of the first to eighth segments, the eighth with two, one posterior, and both, like that of the first segment, mere low, blunt warts; a suprastigmatal series, anteriorly placed on the second to eighth segments, those of the third and fourth segments like those of the laterodorsal rows, those of the second similar, but only half as large, the others scarcely raised warts; an infrastigmatal series of scarcely raised warts in advance of the middle of the fourth to eighth segments; and a latero-ventral series of small warts on the middle of the fourth to sixth segments. Inferior base of cremaster bounded laterally by very broad, coarse, low walls, curving strongly on the posterior half, straight and somewhat approximated anteriorly, each terminating in a small, short, rounded tubercle. Cremaster proper viewed from above, somewhat longer than broad, not large, tapering, laterally tuberculate near base, well rounded at tip; viewed from the side, rather stout, half as long again as broad, straight, equal excepting at tip, where it expands considerably beneath; the apical field of anal hooklets nearly circular. Hooklets very closely crowded, rather short, the stem slender and nearly or quite straight, the crook very strongly curved and considerably enlarged and especially heightened.

This genus is common to Europe and America and appears to be more abundant in the Old World than in the New. It has not yet been found in western North America, but one species at least belongs to Guatemala. Not being autoptically familiar with the many species of Melitaei described from Central America and the northern part of the southern continent, I am unable to say how extensively the genus is distributed; but it will probably be found in all the elevated districts of Central America and Mexico as well as in parts of the great elevated central plateau region of the United States. East of the Rocky Mountains it is confined to the Alleghanian fauna and the southern parts of the Canadian. It occurs in all but the southern portions of New England.

The butterflies are considerably under the medium size, dark brown with deep orange markings; these consist of some transverse patches in the cell and of a mesial and a submarginal, transverse, sinuous series of spots, the latter small in the fore wing and large in the hind wing; in the male the two are confluent; beneath, the wings are orange fulvous, the hinder pair traversed by a basal series of independent, black edged, pale yellow spots, a broad, mesial band of similar but larger and contiguous spots and a submarginal continuous series of black edged, pale yellow lunules; the latter occur also on the fore wings.

The insects are single-brooded and winter as half grown larvae; they remain suspended in the chrysalis state for about a fortnight, and appear on the wing in the first half of June. The eggs are laid in clusters, and the young larvae live in a common web, our species on *Doellingeria*; they desert this before winter, but are again found associated in considerable numbers in spring.

The eggs are tapering, barrel-shaped, with numerous ribs and of a yellow color when just laid. The larvae have a cylindrical and nearly equal body, supplied with a dorsal row and on each side, four other rows of conical tubercular spines, two pairs above and two below the spiracles. They are dark orange with a dusky, longitudinal, stigmatal line, and are heavily marked with black in transverse patterns. The chrysalids are somewhat rounded, elongated, with full abdomen and apically tumid wing-thecae. They are pale yellowish in color, the wings dashed with black, and the dorsal surface is studded with small, conical tubercles which are set off by basal dark-colored rings.

EXCURSUS XXI.—COMPANIONSHIP AND COMMENSALISM
AMONG CATERPILLARS.

Non v'accorgete voi che noi siam vermi
Nati a formar l'angelica farfalla,
Che vola alla giustizia senza schermi?

DANTE.—*Purgatorio*.

Do ye not comprehend that we are worms,
Born to bring forth the angelic butterfly
That flieth unto judgment without screen?

Longfellow's translation.

As a general rule, caterpillars of butterflies live solitary lives throughout their entire existence. The mother drops an egg here and there upon a spot suitable for the food of its young, and here the caterpillar takes up its abode with more or less wanderings. In two of the four families of butterflies there is scarcely a single exception known to this rule, but in the highest family and in a few instances in the Papilionidae, caterpillars during at least a portion of their lives are more or less gregarious. Whenever the caterpillars are strictly gregarious, the eggs are invariably laid in clusters; there are, however, some butterflies which lay their eggs in small clusters, whose caterpillars are not properly gregarious; yet all such are closely related to others whose caterpillars are gregarious, so that we find every gradation from solitary to social. There are also some caterpillars which are gregarious in their early life, but afterward part company. In such cases the caterpillar usually hibernates, and its social life lasts to some degree throughout the autumn and winter, the company dispersing at the renewal of activity in the spring. Indeed, in almost all cases, the association is most conspicuous in early life, when the caterpillars feed in rows upon the same leaf in such close proximity that it would seem to interfere with convenience. Sometimes this is the only mark of their social nature; but as all caterpillars spin more or less silk in moving about, a web of greater or less extent generally accompanies a colony, and in some cases the community constructs a close structure within which they retire to rest or to moult. A Mexican butterfly,

allied to our sulphurs, constructs a web, first noticed by Hardy, which is nearly as close as parchment. With rare exceptions, all butterfly caterpillars feed upon the outside of plants; but there a few which live in the interior, and one of these, an Indian species of *Lycanidae*, is known to be social, living in numbers within the fruit of the pomegranate.

Among our own butterflies, there is nearly every gradation from brief and partial companionship up to a social life which lasts throughout the entire period of larval existence. The weakest form of social life is found in some of the *Polygoniae* (others being purely solitary), where the eggs being often laid in columns of from two to nine, or several eggs being scattered by the mother upon one leaf, the caterpillars in earliest life are naturally found feeding upon one leaf. Rarely are more than four or five found in company, and each takes up its independent position upon the leaf and acts as if the others were not present. As, however, it is their habit to remain upon the leaf until it is almost eaten, they naturally leave it at the same or nearly the same time, and, following a similar instinct, are apt to pass together to the nearest leaf, but scatter more or less, so that by degrees as they approach maturity they are found widely separated from each other. Yet even in this weakest form their numbers are often so great upon a single plant that when they leave it for pupation, the chrysalids hang almost in company, thirty or forty spinning their silken shrouds in such proximity that they may be pulled down together. A somewhat similar or perhaps weaker case may be found in *Pieris rapae*, which often lays a considerable number of eggs singly upon one plant and the caterpillars, naturally seeking the interior of the cabbage head, may often be found in close proximity. But this even more than the preceding is a case of mere accident, from the nature of the food plant upon which they subsist. In all other cases of social life among our caterpillars the eggs are laid by the parent in decided clusters. The slightest of these is probably that of *Laertias philenor*, the masses being ordinarily confined to a dozen or so. The caterpillars in this case not only feed in company but, in earliest life at least, range in rows along the edge of the leaf they are eating, with their heads toward the eaten portion; and in this way they live during at least the earlier half of their lives, scattering more or less after the third moult upon separate leaves, so that at maturity rarely more than one is found upon a single leaf, though the leaf of their food plant is exceptionally large.

This alteration of habit from companionship to solitariness is a natural incident due to growth. Up to the end of the third moult the size of the caterpillar has not increased enough to make it a conspicuous object, but by the time the third moult is passed, the caterpillar is half grown, and during this stage and the next its size becomes an important element in its security; and this alone is sufficient to account for the fact that mature

caterpillars of butterflies are rarely found in company. It is at this stage, too, that in many instances, the winter season overtakes the caterpillar and it hibernates; and since in the spring it revives when the plants have put forth but tender leaves, impossible to nourish more than one or at most two such ravenous beasts as now come out of their winter quarters, such a change of habit would seem to be compulsory. Possibly the change in habit which generally takes place at this middle period of caterpillar life, even when winter does not intervene, is an inheritance from a common ancestor whose habits were fixed by the necessity of hibernation at this age.

As far as our own fauna is concerned, the great mass of social caterpillars are found in the highest family, the Nymphalidae, and indeed in the subfamily of the Nymphalinae, in which this habit is found in most of the principal groups. In some instances, as we have related of *Laertias philenor*, the caterpillars in early life live exposed upon the surface, generally the under surface, of the leaf, ranged side by side, feeding and sleeping in unison. But in most some sort of web is constructed by the caterpillars upon or beneath which they live, and to which, should they wander beyond its limits for food, they retire for rest and moulting. Some use this web with certain alterations in its structure as a winter residence, but then invariably leave it on the approach of spring and part company, though often being still found in near proximity. Others leave it at the hibernating season to seek, each for himself, his own hiding place.

Perhaps of all our caterpillars, although it constructs but a slender web, *Euvanessa antiopa* is the most preeminently social. The eggs are laid in a cluster of greater or smaller size around a terminal twig, which they leave together and as if by common impulse range themselves side by side in compact rows along a chosen leaf. Even if they are separated forcibly from each other, they come together again and rearrange themselves. When disturbed they will simultaneously strike an attitude of alarm and turn their heads in unison as if worked by a machine. The web they form is simply that which they make as they crawl about, each following hurriedly in the track of its predecessor, and as it moves adding its thread to the carpet upon which it treads; and being social throughout their life they are more than usually destructive to foliage, stripping branch after branch, and wandering to the very tips until they are borne down by the weight of the mass. It would seem probable that our *Eugonia* has the same habits from what we know of its European congener, but if so it is exceedingly strange that in only one instance has the caterpillar been seen in this country, and then but a single one, probably one which was hastening to seek a place in which to pupate.

Although it is not stated whether the caterpillar concerned belongs to a butterfly or to a moth, a very curious and interesting case of strict

commensalism has been noted by Fritz Müller (Nature, xv : 264) in South America, in which a large spiny caterpillar was almost invariably found accompanied by a small, hairy caterpillar, so small as to rest securely in a transverse position across the back of its good-natured host, well concealed among its spines; in proof of its continued existence at this point, the skin of the host was hardened beneath the tread of its little guest, so as to have become distinctly more callous than in other parts. Just what advantage this would be to either party, both being feeders upon vegetable matter, it would be difficult to say, excepting that the spinous surroundings might well be of assistance in protecting the smaller beast. But this neat observation of Müller seems to open a field of possible investigation which may have great interest.

*** Notes on this subject by Mr. W. H. Edwards will be found in the Canadian Entomologist vol. xvi: 111-116. See also my Butterflies pp. 104-114.

CINCLIDIA HARRISII.—Harris's butterfly.

Melitaea harrisii Seudd., Proc. Ess. inst., iii: 167-168 (1863);—French, Butt. east. U. S., 170-172. figs. 48, 49 (1886);—Mayn, Butt. N. E., 29, pl. 4, figs. 34, 34a (1886).

Phyciodes harrisii Kirb., Syn. cat. Lep., 174 (1871);—Edw., Can. ent., ix: 165-168 (1877);—Coq., Rep. ins. Ill., x: 162 (1881);—Fern., Butt. Me., 47 (1884).

Limnaecia harrisii Seudd., Syst. rev. Amer. butt., 27 (1872).

Cinclidia harrisii Seudd., Bull. Buff. soc. nat. sc., ii: 266 (1875).

Melitaea ismeria ? Harr., Ins. inj. veg., 3d ed., 288 (1862).

[Not *Melitaea ismeria* Bois.-LeC.; nor *Mel. harrisii* Edw. 1870 and Saund. 1872.]

When the tangled cobweb pulls
The cornflower's cap awry,
And the lilies tall lean over the wall
To bow to the butterfly.
It is July.

SUSAN H. SWETT.—July.

Imago (5: 4, 10). Head covered with dull, brownish fulvous hairs and mingled blackish and fulvous scales: next the eye, just below and just above the antennae is a little tuft of white hairs; the eyes bordered behind, broadly below, narrowing above, with white scales. Basal joint of palpi white with a white fringe: second joint pale orange on the middle of the outside, growing deeper in tint apically, fringed above and below with scales which are white on the lower half, changing to orange above, and with a mixture of black and white and a few fulvous hairs along the whole lower edge and on the apical half of the upper edge with orange hairs, mingled with black; apical joint orange, tinged with brownish, with an intermingling of black scales above, extreme tip black; within, the basal joint is wholly white, the middle orange on the lower half, white above; apical joint orange, with a few black hairs. Antennae black above; excepting a few of the basal joints, annulated with white at the base of the joints of the stalk and of the base of the club; beneath with a line of white externally, broadening upon the club, so as to occupy nearly the whole of its lower surface; beneath, internally, yellowish brown, narrowed toward the apex of each joint, broader on the club; four or five terminal joints of club dull orange, somewhat infuscated above and below. Tongue luteous at base, beyond fuscous the extreme tip luteo-fuscous, with fuscous papillae (61: 42), which occupy only the extreme tapering tip, are situated at the outer margin of the under surface (the basal ones a little inside the margin), are about as long as the breadth of one maxilla, excluding the part form-

ing its share of the central canal, separated from each other by their own diameter at first, but by twice that next the tip of the tongue, cylindrical, four times as long as broad, the tip broadly rounded, sometimes higher on one side, the apical pit slight, partially lateral, and filled by the terminal filament, which is of similar shape, scarcely as long as width of papilla, bluntly pointed.

Thorax covered above with fulvous hairs having an olivaceous tinge, especially on the back; beneath dull whitish; fore legs white, pale orange in front; the other legs orange, the under surface of the femora, together with the under half of the outer surface, and sometimes the base of the inner, white; spines and spurs orange; claws reddish brown; pulvillus fuscous.

Wings dull orange, marked heavily with black, having sometimes a faint purplish lustre, all the veins black. The basal three-fifths of the costal border of the *fore wings* as far as the subcostal nervure black, the basal two-thirds of it powdered with orange scales; at its tip, this black border bends downward as an oblique, broad, nearly equal band, reaching the upper median nervure, its interior edge a little beyond the extremity of the cell, its exterior irregular or zigzag, reaching the median nervure just at the termination of its basal curve; this band frequently encloses, oftener in the male than in the female, an irregular, ill-defined, orange spot, seated on the median nervure; the base of the wing, half way to the divarication of the median nervure, is black, powdered with orange scales; in the middle of the cell, or just beyond it, is a transverse hour-glass shaped black spot, crossing the cell and enclosing two, usually connected, orange spots; the extremity of the cell is marked narrowly with black and forms part of a transverse oval circlet, the other half of which crosses the nervures beyond the cell; just previous to the first divarication of the median nervure, and just beneath the middle of the hour-glass shaped spot, is a short, black, transverse dash, crossing half of the medio-submedian interspace and then, turning inward with a sharp angle, is lost in the obscurity of the base; the extreme base of the lower median interspace is occupied, as far as the second divarication, with a black spot, which forms the summit of a large black patch, broadening below in crossing the whole of the medio-submedian interspace; as far as the submedian nervure, the whole inner border is edged with black; these black markings of the base of the wing are often partially blended, and usually, in the female, to such a degree as to leave only a subpyriform, transverse spot at the extremity of the cell, and a small spot just beneath the first divarication of the median nervure, distinctly orange, the rest of the base being black with a few small blurred orange marks; outer border broadly margined with black, limited interiorly by a line, sometimes obsolete, which starts from the costal border at a distance from the basal black markings equal to the width of a median interspace, and following the general direction of the outer limit of those markings in a deeply sinuous curve, leaving between it and the basal markings a broad, nearly equal, fulvous belt; next its interior edge the outer bordering contains the penultimate subcostal nervule, a series of large orange spots, often tipped outwardly with whitish, and frequently, especially in the male, confluent with the orange band, the only remnants of the outer bordering in this part of the wing being then the heavily edged black nervules; this series of spots is continued above, subparallel to the outer border, by three pale yellow dots or minute spots; midway between this series and the outer border, is sometimes seen, particularly in the female, a series of minute black dots, bordered within and sometimes without with faint, pale or yellowish touches; fringe white, abruptly interrupted at the nervure tips with equal quantities of black. *Hind wings* having the internal border, as far as the submedian nervure, tinged with yellow and more or less begrimed with blackish scales; the whole costal border, as far as the subcostal nervure, and the base of the wing as far as the divarication of the median nervure black; beyond this, as far as the extreme base of the upper median nervure, the wing is traversed by many slender, transverse, black stripes, more or less confused, and, in the female, usually entirely black, excepting a very small orange spot on either side of the veins terminating the cell; but in the clearest specimens there can be distinguished a figure-of-eight spot crossing

the cell near its extremity, a black edging to the extremity of the cell and a narrow stripe crossing the wing irregularly, first from near the middle of the costal nervure to the lower subcostal, in a direction toward the last divarication of the subcostal nervure; then, curving a little outward, across the very base of the upper median interspace, to the middle of the submedian nervure, where it terminates; within this, the medio-submedian interspace is wholly black, sometimes sprinkled with orange; a little within the middle of the outer half of the wing, a vague, moderately broad, arcuate, black stripe runs from border to border, most conspicuous in the female, often wanting in the male or indicated only in the upper subcostal and medio-submedian interspaces, and by a thickening of the black edging of the veins in the middle of the wings; outer margin broadly bordered with black, varying in width from one and a half to two interspaces' breadth, next the costal border, and gradually lessening to less than half an interspace next the inner border; in the lower three interspaces it is edged interiorly by slender orange lunules, surmounted either by black lunules, upon which are planted round, black, occasionally white-pupilled spots, or else directly by the black spots which form part of a series occupying also the next two interspaces, where they are generally smaller and never pupilled; the black border contains also a series of submarginal, transverse, sometimes obsolete, orange dashes, extending, diminishing as they go, from the inner border to the middle submedian nervure; fringe white, rather broadly interrupted at the nervure tips with black.

Beneath rather pale orange, the hind wings a little deeper in color, the veins, excepting the basal half of the median nervure black. The costal border of the *fore wings*, excepting the basal quarter, the extreme tip, and the part corresponding to the extramesial, orange band of the upper surface, which is here dull yellowish, black; a small, triangular, black spot, fulvons at the centre, in the middle of the basal two-thirds of the cell; crossing the middle of the outer half of the cell is a slender, tortuous black line, having, in general, a slight curve opening inward; the extremity of the cell encircled with a large, transversely oval annulus formed of a slender line which does not touch the extremity; beyond the cell, corresponding to the outer limit of the black markings of the upper surface, is a slender, black, oblique streak, frequently broken into small spots, extending from the costal to the median nervure; a subapical, black patch, depending from the costal margin, fills the upper interspaces as far as the middle or lower of the subcostal interspaces, which lie within the field occupied above by the black bordering of the outer margin; the latter is edged with black, followed by a series of orange lunules of varying height, but in general equal to three-quarters of an interspace, edged narrowly within with black, and followed by a series of equally irregular, but much smaller, whitish lunules, some of which, especially those in the lower subcostal and subcosto-median interspaces, are occasionally obsolete; these two are bordered within with black in the form of narrow lunules or sagittate spots, and these again are followed by a very sinuous series of faint, yellowish white spots, starting on the costal border from near the middle of the subapical, black patch, curving outward to the lower subcostal interspace, then inward to the median interspaces, that in the medio-submedian interspace being but an interspace's distance from the border. *Hind wings* with a small, dull silvery spot edged with black at the extreme base of the costal margin; a series of three similar, but slightly larger, irregular spots, edged with black and separated only by the black veins, the middle one largest, nearly square, in the costo-subcostal interspace, its outer edge at the first divarication of the subcostal nervure; the one in the interspace above, just above the base, the one in the cell a little removed toward it, crossing the cell only by its inner border; the extremity of the cell is occupied by another spot of similar size, edged entirely with black; and the medio-submedian interspace by another, exactly similar, its outer, upper corner touching the inner, lower corner of the previous at the first divarication of the median nervure; just below the latter, in the submedio-internal interspace, is sometimes seen a very small, longitudinally fusiform, black edged spot. There is a broad, silvery, mesial band, tinged with brownish yellow, crossed by black veins and

bordered within and without by a broad, blurred, black edging; the interior limit is irregular but has a general arcuate direction from the middle of the costal to the lower median nervule at an interspace's distance from its origin, and having a slight indentation in the upper subcostal interspace; at the lower median nervule, it turns abruptly and diagonally, in a straight line, to the submedian nervure at three-fifths the distance from its origin and then turns upward to the internal, to its former distance from the base; the band is broadest on the upper half of the wing and the exterior border is more regular, extending, subparallel to the outer border, from the costal to the submedian nervure at a distance of about an interspace and a half from the outer border to the tip of either; this band is traversed by distinct, rather regular, black lines: one passes from the costal to the upper median nervule, barely separated from the interior border; another crosses the same interspaces at a little further remove from the exterior border; another crosses the median interspaces near the middle of the band; others cross the upper tip of the band in the medio-submedian and submedio-internal interspaces, and still another crosses the medio-submedian, midway between the upper line and the exterior border; the outer margin is edged with black, followed by a series of nearly equal, orange lunules, largest in the upper two interspaces, all edged with black and followed by a series of black edged, silvery lunules of variable size, enclosing between themselves and the exterior margin of the mesial band, at least from the lower subcostal interspace downward, large orange spots, having, beyond the middle of each, a small, white-pupilled, black spot; fringe as on the upper surface.

Upper surface and sides of abdomen black, speckled slightly with fulvous scales, each segment edged apically with pale tipped fulvous scales; beneath white, the apical half tinged rather strongly with buff; a slender, lateral, black line interrupted at the tips of the segments; terminal segment tipped with pale orange scales. Clasps of abdominal appendages (34: 7, 8) fully half as long again as broad, constricted before the extremity; apical spines somewhat compressed, the lower a little shorter than the upper, both tapering to a fine point and strongly curved; the lower curves first downward, then inward and backward and finally upward; the upper curves first inward and then strongly forward; interior tooth stouter, also compressed and tapering, but not to a point, arched over inward.

Measurements in millimetres. Length of tongue, 6.25 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	18.5	19.5	20.5	16.75	21.5	21.5
antennae.....	9.25	9.5	9.25	7.5	10.	10.
hind tibiae and tarsi..	6.	6.	6.	5.	6.25	6.25
fore tibiae and tarsi..	2.	2.	2.	2.25	2.5	2.5

Described from 17 specimens, of which 8 were ♂, 7 ♀.

Suffused variety. A female I saw in the collection of the late Mr. H. K. Morrison had the two transverse rows of orange spots upon the upper surface of the fore wings suffused into a common band, whose inner limit crossed the middle of the wing, and, besides, the dusky marking of the basal half of both wings much less conspicuous than usual; but the departure from the normal type was inconsiderable and confined to the upper surface.

A specimen reared by Mr. Edwards, south of its proper range, from a caterpillar abnormally black, had "the fulvous pattern obscured, as if washed with black."

Egg (64: 41). With about twenty-four vertical ribs on the upper half of the egg, becoming slightly less prominent and more uncertain in course in the lower half, being more or less merged in the polygonal depressions which here take the place of the almost imperceptible system of cross lines breaking the interspaces between the ribs in the upper half into rectangular cells, not much broader than high; the surface is otherwise smooth. Summit covered with a tracery of very delicate reticulations (67: 14) forming polygonal, and generally, especially as they approach the centre,

more or less cuneiform cells; the outer, larger and more regularly polygonal, are about .03 mm. in diameter; those of the central rosette about .0125 mm. long and .0075 mm. broad. Color pale lemon yellow. Height of egg, .58 mm.; breadth, .46 mm.; diameter of summit, .28 mm.

Caterpillar. *First stage* (72:1). Head (79:20) shining blackish brown; labrum pale; rest of mouth parts dusky. Body pale bluish green, darkest along a lateral line, the incisures dusky; the sides tinged with yellow, the first segment with purple; warts and hairs (86:54) black. Legs black; prolegs dusky at tip. Length, 1.75 mm.; breadth of body, .25 mm.

Second stage. Head (79:21) uniform blackish brown. Body yellow, with a rather broad, dark brown, lateral stripe, and both back and sides faintly and delicately marked with streaks of yellowish brown. Hairs black. Prolegs dusky at tip; legs fuscous throughout.

Third stage. Head (79:22) black, shining. Body yellow, with a slender, dark brown lateral line and numerous transverse, delicate dark streaks; spines (86:55) black, twice as high as broad, with a terminal, slightly bent hair, fully as long as the spine, and frequent shorter, lateral, black spinules, those of opposite sides at rather more than right angles with each other. Prolegs dusky; legs blackish.

Fourth stage. Head (79:23) black, shining. Body yellow, with a narrow dorsal, interrupted laterostigmatal and faint stigmatal dark brown stripes, with narrow transverse stripes of dark brown next the incisures; first thoracic and last abdominal segments infuscated. Legs blackish; prolegs dusky outside. Spines (86:56) yellow at base, beyond black, fully three times as long as broad, regularly tapering, bluntly pointed, all the spinules black and of nearly equal length, and about half as long as the spine, mounted on little tubercles; spiracles dusky.

Fifth stage (75:13, 14). Head (79:24) pitchy black, beset rather sparsely with long and delicate hairs; antennae and mouth parts black. Body deep orange, the first thoracic segment black specked with orange, the others with the following black markings: a distinct continuous dorsal line; a transverse sutural line between the segments, often broadening into a transverse dusky patch on the sides; a submarginal transverse line near the posterior edge of the segments, often broken before reaching the dorsal line, and generally connected with the interstitial line near the spiracles; a more or less distinct, often nearly obliterated dusky transverse band, connecting the bases of the spines and encircling the spiracles; and connected with this an interrupted, longitudinal, stigmatal line, dusky rather than black; in some more infuscated individuals the transverse bands and the transverse lines are connected by occasional longitudinal streaks, giving the whole body, or at least the sides, a mottled appearance; in some of these individuals the brighter colors become dimmed, giving a close resemblance to darker forms of *E. phaeton*. Spines (86:57) shining jet black, the needles black. Spiracles black. Legs black; prolegs brown. Length of body, 22 mm.; breadth, 3.5 mm.; breadth of head, 2 mm.; length of spines, 1 mm.

One caterpillar reared by Mr. Edwards in West Virginia was almost black in the last stage, the lighter color being restricted to a few specks and dots on the back of each segment.

Chrysalis (84:17, 18). Snowy white, with a slight tinge of bluish or pale salmon, the abdomen often obscured a little with fuscous. Head with a transverse black band on the front edge, generally passing around the outside of the ocellar prominences a short distance, and at the interior base of each antenna a small black spot; behind these, along the front edge of the mesonotum, a curving row of four small black spots, two subdorsal and two occupying the prothoracic spiracles; on the summit of the mesonotum a pair of short, slender, oblique, slightly curving subdorsal streaks, the convexity inward and somewhat backward; tongue black. Legs white, tipped with black; antennae alternately white and brown tipped with black. Wings with a large, longitudinal, curving, interrupted, mesial, black stripe, tapering at either end, and at its longest starting from near the base at the lower edge, and terminating near the

upper part of the hind margin, its convexity downward, broadly interrupted at the nervures with brownish yellow; when shorter it is often made up of four or five sub-lunate patches, and its general curve is a little greater; besides other little black dashes, which are often obsolete, there is a large longitudinal black dash at the middle of the hind border, the broadest extremity resting on the edge; the basal wing tubercle is heavily and irregularly marked with black, and there is a transverse black bar on the under wing next the hinder edge of the thorax; the hinder edge of both wings, and especially of the under, is pale orange. The incisures of the abdominal segments are also pale orange. There is a broad stigmatal band formed of alternate quadrangular black and orange spots, and a similar but broader ventral band. On the posterior portion of the second to seventh abdominal segments there is a subdorsal row of small, transverse, vaguely defined spots, which occasionally become oblique, diverging anteriorly; there is a lateral row of brownish dots on the middle of the abdominal segments. All the larger tubercles of the thorax and abdomen are orange tipped with black, and have a black edging at their anterior base. All the smaller warts, especially those which are scarcely raised above the surface in the suprastigmatal, infrastigmatal and lateroventral series are black and very distinct. Spiracles black. Cremaster black beneath, above black and white in alternate longitudinal stripes, to near the tip, which is bluish white edged with black; the terminal segment is sometimes black. Length, 12.5 mm.; breadth, 4.5 mm.; height of thorax, 3.75 mm.; of abdomen, 5 mm.

By some strange confusion for which I cannot now account, I stated in my revised list of New England butterflies (Proc. Bost. soc. nat. hist., xi: 379) that Harris's *Mel. ismeria* belonged to *Charidryas nycteis* and not to the present species, as I had said in first describing the species. Both the specimen from Sutton and the description by Harris show that my first assertion was right. Strecker's statement regarding the matter is perfectly correct.

Distribution (22: 6). Data are wanting whereon to base any exact account of the distribution of this insect outside of New England. Mr. W. H. Edwards states that it is found in Quebec, Ontario, New York, Michigan, Illinois and Wisconsin. Rev. Mr. Fyles records it from near Quebec, where also Mr. Bowles has found it, and it is looked on as very rare at Montreal by Mr. Caulfield. Mr. Fletcher writes me that it is also found at Nepigon, north of Lake Superior, and at Sudbury, north of Georgian Bay, and also on the Gaspé coast south of the Gulf of St. Lawrence, and in New Brunswick. Mr. Peabody took a specimen in Wisconsin, and it is catalogued as "not common" in this state by Dr. Hoy. Mr. Worthington has captured it in northern Illinois, and Mr. Lintner in Albany Co., N. Y., while it is reported by Dury as "not common" about Cincinnati, Ohio. In this last case I suspect the species is wrongly determined, as it is far south of its otherwise known range, which may be properly said to lie in a narrow belt westward from New England along the 43d or 44th parallel, and probably its proper home would be fairly well traced by the mean annual isotherm of 45°. It has not been reported from the Adirondacks but must certainly occur there in abundance. Mr. Jones records it as "scarce" in Halifax Co., Nova Scotia, where Belt mentions captures at Lakes Loon and Thomas.

In New England, like *Charidryas nycteis*, it is found in distant and very various localities. In Maine it has been found at Orono (Fernald), Brunswick (Fish), Portland (Lyman) and abundantly in Norway (Smith). In New Hampshire it is plentiful at the White Mountains and has also been taken at Pittsfield (Treat), Dublin (Faxon) and at Milford, where it is "rare and local" (Whitney). In Vermont it is recorded only from Montpelier (Sprague) and Stow, "very abundant" (Miss Soule); and in Massachusetts from West Roxbury "a single specimen" (Minot), Malden (Sprague), Sutton (Harris), Princeton (Scudder) and Springfield "rare" (Emery, Dimmock). South of Massachusetts it is not known. It seems, therefore, to be more common in the elevated and northern districts, and to belong more strictly to the Canadian than the Alleghanian fauna. On the road from Fabyans to the base of Mount Washington, where one rises 1000' in a distance of six miles, I noticed in the early part of August that though *Doellingeria* grew as abundantly on the upper as on the lower half of the road, as marked by the Twin River Farm, nests and caterpillars were only to be found on the lower half. This would indicate either that it is either extremely local or that it does not readily attain a higher altitude in that region than about 2200'.

Oviposition. The eggs are laid in patches of twenty or upwards apparently only in a closely crowded single layer, upon the middle of one side of the under surface of the food plant, a leaf about half way up the plant being chosen. In one case, in confinement, an unimpregnated female, about a week or ten days out of chrysalis, laid on the side of a tube from which she was sipping *eau sucré*, a mass of about sixty eggs somewhat pell-mell, but the bottom ones in a pretty solid layer. She appeared to be too intoxicated or exhausted to lay more, fell to the ground and died before morning, her body still crammed with eggs.

Food plant. The caterpillar feeds exclusively upon one of the Compositae, *Aster* (*Doellingeria*) *umbellatus* Torr.-Gray. Prof. S. I. Smith, who was the first to discover the early stages, has also found it on *Chelone glabra* L. and another *Aster*, but it was not seen to feed upon either, and in confinement ate only the *Doellingeria*. Mr. Edwards gave larvae, sent to him to West Virginia, leaves of *Chelone*, "but so long as the least bit of the dry leaf of *Diplopappus* [*Doellingeria*] on which they hatched remained, the larvae declined the *Chelone*, and then after starving many hours they attacked it vigorously. . . . The first moult was passed and the larvae now utterly refused *Chelone*. I gave them *Aster* and on this they fed readily to the last, eating any species indifferently." With three species of *Aster* growing abundantly everywhere along the roadside at the White Mountains in the spring, in company with *Doellingeria*, one or two of which it took me some time to learn always to distinguish, the caterpillars found on a hundred different plants were always on the *Doel-*

lingeria and never on the other Asters, or if there, had not fed upon them. Specimens brought to Cambridge starved rather than touch Aster (*Ianthe*) *linariifolius*, which like its food plant was formerly placed in *Diplopappus*.

Habits of the caterpillar. The young caterpillars first attack the apical half of the leaf on which they are born devouring only the parenchyma of the under surface, and then march in company straight to the summit of the plant, begin upon the tenderer leaves, and next move down the plant, devouring the parenchyma of both surfaces as they go and covering everything with a thin web, beneath and upon which they live. They continue to live in society while young, forming nests not very unlike those of *Euphydryas phaeton* (82: 8); but these nests they desert before winter and hibernate probably in curled up dead leaves or beneath sticks and logs. In the spring they awaken early, and although they do not properly seem to live in company at this season, and spin no kind of web they are rarely found alone, and generally may be discovered in large numbers on *Doellingeria*; sometimes twenty may be seen upon a single stalk, and often four or five upon the same leaf. This is a result doubtless of their having no such proneness to stray as is the habit of *Euph. phaeton*, for both Mr. Morrison and myself have found them in the spring in the precise stations in which they had been seen the preceding autumn along a road where *Doellingeria* was continually found. They must therefore hibernate in close proximity to their birth place. When about to moult, the caterpillars leave the plant and retire to a dead stick or leaf for the change, and then return to their pasture ground.

They feed both while upon the upper and under side of the leaf, eating from the edge to the midrib or sometimes gnawing irregular holes through different parts of the leaf; and thus frequently stripping the plants quite bare. When *Doellingeria* has gone to seed—in northern New England about the second week of September, they have deserted their nests and are nowhere to be found. Search made about the roots of the plant by Mr. Smith was wholly fruitless. In the spring the caterpillars devour the whole plant excepting the stem and the midribs of the leaves. When young and feeding in company they manifest alarm “by a jerking motion of the body from side to side, the last segments being fixed to the leaf, and all the larvae jerking together” (Edwards). Their behavior throughout, says Mr. Edwards, “was like [that of] the larvae of *nycteis*, though they are cleaner in feeding.” They eat by day only, resting quietly by night, and often when disturbed, make a scraping noise by turning the head half way around and scratching the mandibles forcibly and repeatedly on the ribs of the leaf they are eating.

Life history. It is single brooded and winters as a half-grown caterpillar. It appears on the wing about the middle of June,* continues to

* Mr. Edwards tells us that transported to West Virginia the spring larvae developed so as to become butterflies earlier, the earli-

est by June 4. Some caterpillars which were carried through the winter there, reached maturity May 26.

emerge until the end of the first week in July and flies until the first of August. The eggs are laid in clusters late in June and in the early half, perhaps the first three weeks, of July. Their duration is not known but the caterpillars, after moulting two or at most three times (the larva being variable in this habit), seek winter quarters in the early part of September. During the second week of a certain September Professor S. I. Smith found the caterpillar in the third stage still living in webs, while another year by the middle of the month only deserted nests were to be found; it is doubtless then at just about this time that the caterpillar seeks hiding places on the surface of the earth. Toward the end of May and early in June it attains its growth, and after passing from ten to sixteen, usually thirteen, days in the chrysalis,* under boards or logs lying on the ground or attached to the under surface of leaves of *Doellingeria* or other plants, it appears on the wing at the time stated.

This butterfly is rarely seen in collections on account of its local habits; it occurs only in the immediate vicinity of spots where *Doellingeria* grows. At the proper season, in the Norway locality, the caterpillars may be found covering the plants, which grow at the edge of a small, boggy, reedy meadow surrounded by thickets and light woods.

Attitudes. As the butterfly hangs from the chrysalis skin before its virgin flight, the antennae are spread at an angle of about 90° and at less than a right angle with the vertical, while the club, as if it were heavy, droops a little more than the stem. At night it rests with the wings erect, the fore wings lowered between the hind pair so that the costal margins are parallel and close together throughout most of the length of the hind wing; and the antennae stretched out in front droop a little in a broadly sinuous curve from the plane of the body, and divaricate at an angle of about 120° . In the day it often rests with its wings completely expanded, nearly as much as in pl. 5, fig. 4, the antennae scarcely raised above the plane of the wings and so widely separated as to be exactly parallel to the costal margin of the fore wings. In walking up a vertical twig it makes not the slightest use of its front legs.

Experiments with cold. Mr. W. H. Edwards has experimented on this butterfly by placing chrysalids less than a day old in a vessel in an ice house in direct contact with the ice for periods varying from nine to thirty days. Some of those exposed the longest perished; such as did not gave butterflies as long after freedom from the cold as their natural term of chrysalid life, viz.: five to eight days. More than one-half of the chrysalids exposed for nine days were not affected at all, and what is curious, these were all put on the ice when only six hours old; the others placed on the ice at eighteen and twenty hours "were much changed . . . chiefly by the restriction or obliteration of the buff bands and spots on

* When transported south, beyond its range, the chrysalis hangs only from five to nine days.

under surface," and particularly those of the median macular band; in one instance the upper surface of the wings was melanized. A pair exposed for eighteen days, one five hours, the other eighteen hours after pupation, were altered in a different manner, and the one placed on the ice when eighteen hours old the most, the upper surface becoming here very melanic, the fulvous area occupying only narrow bands; while both were altered differently from those exposed to the cold a shorter time, and in a manner which is not at all a simple excess of the differences seen before but the reverse; for though, as before, it is the buff spots of the under surface of the hind wings which are affected, these in the present examples were more or less confluent in the outer half of the wing, showing the precise quality termed suffusion. A third set exposed for twenty-six to twenty-nine days (one at twelve hours old, the others not stated), were altered on both surfaces "by restriction and obliteration of the fulvous on upper side, and the [nearly complete] obliteration of both buff and fulvous on lower side," besides being partially or wholly crippled.

It will be noticed that these forced differences do not agree with those of an individual naturally matured, described on a preceding page.

Desiderata. The duration of the egg stage is unknown. The earliest stage of the caterpillar has been insufficiently studied. Some observers have spoken of the autumn caterpillars as making no common web; is there any variation in this respect? and how does the nest differ from that made by its allies? Those who can follow the caterpillars in the field should carefully watch their actions at the moment of hibernation; do individuals of the same colony hibernate in common and collect on the same plant in the spring, or do they mingle indiscriminately at that season? The characteristics of the flight of the butterfly should be described.

LIST OF ILLUSTRATIONS.—CINCLIDIA HARRISII.

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| <p><i>General.</i></p> <p>Pl. 22, fig. 6. Distribution in North America.</p> <p><i>Egg.</i></p> <p>Pl. 64, fig. 41. Colored.</p> <p>67:14. Micropyle.</p> <p><i>Caterpillar.</i></p> <p>Pl. 72, fig 1. Caterpillar at birth.</p> <p>75:13. Abdominal segment of a mature caterpillar enlarged.</p> <p>14. Mature caterpillar.</p> <p>79:20-24. Front view of head, stages i-v.</p> <p>82:8. Nest.</p> <p>86:54. Dermal appendage at birth.</p> <p>55-57. Same, in stages iii-v.</p> | <p><i>Chrysalis.</i></p> <p>Pl. 84, fig. 17. Side view.</p> <p>18. Dorsal view in outline.</p> <p><i>Imago.</i></p> <p>Pl. 5, fig. 4. Male, both surfaces.</p> <p>10. Female, upper surface.</p> <p>84:7, 8. Male abdominal appendages.</p> <p>39:3. Neuration.</p> <p>54:4. Side view of head and appendages enlarged, with details of the structure of the legs.</p> <p>61:42. Papilla of tongue.</p> |
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EUPHYDRYAS SCUDDER.

Euphydryas Scudd., Syst. rev. Amer. butt., Melitaea (pars) Auctorum.
27 (1872).

Type.—*Papilio phueton* Drury.

Straight from the filth of this low grub, behold!
Comes fluttering forth a gaudy spendthrift heir,
All glossy gay, enamel'd all with gold,
The silly tenant of the summer air.

THOMSON.

Imago (54:5). Head moderately large, clothed, not very thickly, with rather short hairs, longer about the anteunae. Front slightly tumid, scarcely flattened at the central portion, very slightly protuberant below, the whole projecting a little beyond the front of the eyes, somewhat broader than long, about three-quarters the breadth of the eyes; upper border descending rather rapidly in front of the antennae; lower border very abrupt and scarcely rounded. Vertex not very large, considerably tumid, projecting considerably above the level of the eyes behind, nearly twice as broad as long, the posterior border broadly rounded, the anterior descending roundly to the anteunal pits. Eyes moderately large and full, naked. Antennae inserted with their posterior border in the middle of the summit, in distinct, very deep and large pits, separated by a space nearly equal to the diameter of the second antennal joint; considerably longer than the abdomen, composed of thirty or thirty-one joints of which ten or eleven form the club, which is naked, pretty strongly depressed, increases quite gradually in size until, with the third or fourth joint from the tip, it begins again to diminish in size, the extremity being broadly and rapidly rounded; the increment in size is mostly on the outer side, and the club is about three times as broad as the stalk and less than four times as long as broad, without carinations beneath; the joints, both of the club and of the apical half of the stem, are rather prominent at their tips, especially on the outer side. Palpi not long and moderately stout, about half as long again as the eye, directed upward and a little forward, the last joint scarcely more than one-third as long as the penultimate, but sparingly clothed with the dense fringe of coarse hairs and scales which cover the upper and under surface of the other joints, and which are much shorter here than there; near the tip of the upper surface of the middle joint a number of long scale-like hairs are directed upward, encircling the eye; all the longer clothing lies in a vertical plane.

Prothoracic lobes moderate in size, strongly appressed, tapering transversely toward either end, the ends well rounded and nearly equal, the upper surface broadly rounded, about three times broader than high. Patagia nearly flat, moderately broad and quite short, scarcely half as long again as broad, the basal portion somewhat circular, the posterior lobe being a pointed, straight, rapidly tapering projection of the hinder part, terminating in a bluntly pointed tip.

Fore wings (39:1) scarcely twice as long as broad, the costal margin almost straight, the apex rounded off; outer margin very broadly and regularly rounded (♀), the upper two-thirds broadly and regularly rounded, the lower portion discontinuous and straight (♂), the general direction being at about 40° with the middle of the costal margin; inner margin straight, angle rounded off. First superior subcostal nervule arising shortly before the apex of the cell; the second at about the same distance beyond the tip of the cell (♂) or at the apex itself (♀); the third half (♂) or a little more than half (♀) way from the apex of the cell to the outer border; second inferior subcostal nervule arising two-fifths way down the cell; the latter considerably less than half the length of the wing and three and a half times longer than broad; last median nervule connected, at a short distance from its base, with the vein closing the cell.

Hind wings with the costal margin pretty strongly and roundly shouldered at the base, beyond straight, the outer angle broadly rounded; outer margin strongly

rounded and pretty full in the upper two-thirds, almost angulated in the ♂, beyond straight, in the ♀ scarcely receding near the anal angle. Inner margin slightly convex on the powdered basal three-fourths, beyond excised and scarcely emarginate, the angle rounded off. Precostal nervure directed straight upward, but close to the tip bending rather abruptly outward. Second subcostal nervule originating but a short distance beyond the first; cell open, but with remnants of the cross vein lying scarcely beyond the second divarication of the median nervure.

Fore legs long, cylindrical, in the male rather abundantly fringed, especially on the outer side, but also above and a little on the inner side, with long, considerably spreading hairs; tibiae two-fifths the length of the hind tibiae; tarsi either four-fifths (♂) or seven-eighths (♀) the length of the tibiae; consisting either of two equal joints, the last abruptly docked and armed at the tip with a short, central, slender spine, nearly as long as the width of the apex of the tarsus, and apparently also with a pair of lateral fleshy spiniform fingers, nearly as large as the spine (♂); or of five joints, the first nearly twice as long as the others together, the second occupying two-fifths of the remainder and the others decreasing regularly in size; all but the last furnished at the tip beneath with a pair of quite long and slender spines, those of the first joint nearly recumbent, the others supported beyond by slender bristly spines, seated upon the succeeding joint; the first joint is considerably stouter than the others, and the three following ones supplied with central, lateral, delicate spines beneath (♀). Middle tibiae scarcely shorter than the hind tibiae, both furnished on either side beneath with a row of quite long and slender, infrequent spines, branching considerably, the apical ones developed as pretty long, slender, tapering spurs; on the inner side also are a few very small spines, mostly arranged in a single broken row next the upper surface. First joint of tarsi scarcely equaling the rest together, the three following decreasing regularly in size, the fifth fully equalling the second; furnished beneath with four rows of moderately frequent, short and slender spines, the apical ones of each joint a very little longer than the others. Claws small, moderately slender, curving considerably, finely pointed; paronychiae double, the anterior lobe nearly as long as the claw, not very slender, but little curved, tapering considerably to a fine point; inferior lobe fully half as long, rather slender, equal, curving inward; pulvillus rather large, well rounded, broader than long.

Abdomen: male appendages; upper organ supplied apically with two short, pointed, lateral processes at some distance apart, each bearing a minute subapical thorn; clasps small, stout, subquadrate, strongly convex, a stout, but not very large, inferior process at the base and an interior, central, laminate, bifurcate tooth of considerable size.

Egg. Compact, subglobular, much taller than broad, the base broadly and considerably rounded, broadest near the middle of the lower half, the sides tapering with a slight curve, the summit less than half the size of the base, squarely docked, flat, or slightly concave, furnished with a considerable number of faint, equidistant ribs, running from the edge of the summit less than half way down the sides; surface nearly smooth. Micropyle rosette occupying the whole summit of the egg with cells of a larger size than usual, generally elongated and bounded by fine lines.

Caterpillar at birth. Head well rounded, broadest at about the middle, where it is very slightly angulated, fully as broad as high, the crown of each hemisphere a very little tumid, a very few rather short hairs. Body cylindrical, very slightly depressed, the apical half tapering slightly, furnished with longitudinal rows of small, rounded warts, one to a segment in each row, each wart giving rise to a moderately short, very slender, tapering, delicately pointed, apparently naked, but in reality delicately spiciferous hair; they are disposed as follows: a laterodorsal row in the centre of the segments, a lateral row at their posterior extremity, a suprastigmatal row again in the centre, an infrastigmatal row of warts smaller than the others on the posterior extremities of the segments, and a ventrostigmatal row on the anterior portion of the segments. On the thoracic segments all the warts are centrally placed. Legs long and pretty slender, the terminal joint tapering but little, the claw pretty long, tapering,

gently curved; prolegs pretty long, large at base, the last joint much slenderer and exerted, armed each with a nearly complete circle of seven slender hooklets, curved exceedingly.

As appears by this description, Gruber has given an inaccurate account of the first stage of this insect, so much so that I at first thought he must have had specimens before him which were wrongly named; but as similar errors occur in the allied forms, it must be set down as an error of observation. No distinction is made by him between the character of the spicules on this and the other genera of *Melitaeidi* and *Argynnidi*; in the present genus, however, they are excessively slight, scarcely perceptible with an enlargement of 250 diameters, while in *Phyciodes* they are distinct enough, and in *Brenthis* almost conspicuous. But a worse error is found in his statement of the disposition of the bristles, as they are *all* paired and there is no mediodorsal row.

Mature caterpillar. Head well rounded, broadest in the middle, fully as broad as high, the sides broadly rounded, the summit of either hemisphere a little tumid, slightly protuberant a little outside and in front of the middle, the suture between pretty deeply depressed, deepest in the middle, the front appressed but not flat; triangle more than half as high as broad, reaching about to the middle of the front, the sutures a little impressed; the whole head covered with minute and larger tubercles, smallest and least abundant on the front, largest and most abundant on the summit, the largest at the highest point, conical, and as broad as high, all emitting rather long, scarcely tapering, bristle-like hairs. Antennae with the second joint short, less than half as long as broad, the third considerably slenderer, fully twice as long as broad, bluntly rounded at the tip, the fourth minute. Ocelli six in number, five of them arranged in the third of a semicircle, its convexity forward, the middle three closely approximate, the upper and lower at about their own diameter's distance from the nearest one, the sixth behind the others, at equal distances from the second and fifth, counting from above, and forming with them a right angle. Labrum not very large, well rounded, broadly ridged longitudinally, the front margin broadly and roundly excised to a moderate depth. Mandibles small, slender, not broad, armed at the edge with four or five sharp triangular denticles, a little longer than broad. Maxillary palpi short and rather stout, the two lobes reaching the same point, the joints similar to those of *Cinclidia*. Spinneret short, moderately slender.

Body cylindrical, tapering forward somewhat on the thoracic segments, otherwise equal, furnished with many spines arranged in longitudinal rows, one in a series to a segment; the spines are moderately long, pretty stout, tapering regularly to a blunt tip, and supplied pretty abundantly with small, conical wartlets, as high as broad, each bearing a scarcely tapering, needle-like thorn, nearly or quite as long as the spine itself, and directed upward very little above the horizontal; they are of nearly equal length in all parts of the body, and are arranged as follows: a dorsal row placed anteriorly, upon the first to eighth abdominal segments, the last with two, the supplementary one placed posteriorly; a laterodorsal series, placed a little in advance of the middle of the segment, upon the second and third thoracic and the first to eighth abdominal segments; a laterostigmatal series, placed anteriorly on the second to third thoracic and first to ninth abdominal segments, the last with two longer than the others, the supplementary one placed posteriorly; an infrastigmatal series placed centrally on the thoracic and first to eighth abdominal segments, and a ventro-stigmatal series placed centrally on the thoracic and the first to seventh abdominal segments, the second to sixth abdominal segments having two each; the first thoracic segment, besides the spines mentioned, has a pair of subdorsal spines, very small, but crowded with warts as large as those on the other spines, and bearing as long hairs; and a double, supralateral, similar one placed transversely, all on the anterior part of the segment. Body sprinkled rather sparsely with moderately long, tapering hairs seated on minute warts. Spiracles small, obovate, half as long again as broad. Legs small, short, appressed, rather slender, tapering, the claws moderately slender, pretty strongly beveled at base, beyond tapering, gently curved. Prolegs very short and moderately stout, tapering a little, with about twenty hooklets arranged in a double

row on the inner half of a circle, moderately distant from each other, the hooklets themselves being very slender, equal, delicate, pretty strongly curved.

Chrysalis. Viewed from above the anterior curve is considerably broken in the middle in front by the very slight protuberance of the base of the ocellar prominences; the latter not at all pronounced but very blunt and rounded, slightly ridged posteriorly on the outer edge of the anterior face; front of head, including the prominences, scarcely concave, and not more so next the prominences. On a side view they are angulated, with a small, rounded tubercle projecting downward very slightly at the angle, a little swollen at the base of the inferior surface, the latter in direct continuation of that of the whole anterior part of the body, the anterior face of the prominences bent at an angle of 135° with the parts above it. Inferior surface of body, as far as near the tip of wings and including the ocellar prominences, straight. Thorax roundly arched in a longitudinal direction but not greatly elevated, regular excepting a very slight, roundly angular prominence, a little in advance of the middle of the posterior half of the mesothorax. Basal wing tubercle similar to that of *Charidryas*, but rather more prominent and longer; its posterior ridge is but little raised, its edge much rounded, constantly lowering, with no supernumerary tubercle. Prothorax without tubercles. Abdomen broadly and regularly arched longitudinally; a laterodorsal series of blunt, conical, medium-sized tubercles on the middle of the meso- and metathorax and the first to ninth abdominal segments, those of the first, eighth and ninth abdominal segments smaller and more rounded than the others. The abdomen is also furnished with a dorsal series of similar tubercles on the anterior border of the first to eighth segments, those of the first to third, and especially the first, smaller than the others; there is also a much smaller, posterior, rounded wart on the eighth segment; a suprastigmatal series of slight, broad, rounded elevations, a little in advance of the middle of the second to eighth segments, those of the third to fourth segments elevated to conical tubercles similar to, and nearly the size of, those of the laterodorsal row; an infrastigmatal series of similar low elevations on the middle of the fourth to eighth segments, those of the fourth slightly higher; and a lateroventral series of very slight, transverse elevations on the fourth to seventh segments, one on the fourth and seventh, two each on the fifth and sixth, all placed at or near the middle of the segments. Inferior base of cremaster bounded laterally by very broad walls, distinct posteriorly, scarcely raised anteriorly, sinuous, converging a little anteriorly, each terminating in a rather small, rounded tubercle, scarcely longer than broad, directed forward and downward. Cremaster proper viewed from above not very large, as long as broad, tapering strongly and regularly except in bearing next the base a very prominent, slightly tapering, outwardly and posteriorly directed, rounded tubercle nearly twice as long as broad; rather squarely docked at apex, channelled rather deeply and narrowly down the middle; viewed from the side it is strongly curved, stout, enlarging regularly, the apical field of anal hooklets longitudinally oval. Hooklets with the stem pretty long, very slender, and nearly or quite straight, the crook greatly enlarged, especially in a vertical direction, and very strongly curved over, the tip pointed.

This genus appears to have but a single representative, which is indigenous to eastern North America; species of very closely allied genera are found in the western half of North America and in the northern parts of the Old World, but are wanting in the region where this genus occurs.

The butterflies are of medium size with rather elongated wings, blackish on both surfaces, with a rather broad reddish margin, cut by black nervules and preceded by pale yellow lunules; between these and the middle of the wing is a double or treble, parallel, curving or sinuous series of small, pale yellow spots and the base of the wing is marked, especially

below, with a rather confused mass of reddish and pale yellow, irregular spots. The antennal club is naked.

The insects are single brooded and winter as half grown caterpillars; the chrysalis state lasts about a fortnight and the butterflies appear about the middle of June. The eggs are laid in large clusters and the caterpillars feed in company on *Chelone* and *Lonicera*, forming nests to which they constantly retire and in which they pass the winter after the third moult; these are deserted in spring and the caterpillars live wholly exposed.

In one of the species of the very closely allied genus *Lemonias*, L. *chalcedon*, the larvae have a similar habit of hibernation after the third moult; but according to the observations of Mr. Wright, they behave very differently according as they live high up in the mountains or in the sun-baked valleys of southern California; in the first instance they construct webs of considerable toughness in which to hibernate, as in *Euphydryas*; while in the valleys they leave the slighter webs they construct in early life and crawl into the ground to hibernate.

The eggs are subglobular, larger below than above, rounded beneath, truncate above, the upper half ornamented with slight and rather frequent ribs; they hatch in about twenty days. The juvenile larvae have a body furnished with small warts, giving rise to rather short tapering hairs, all arranged in five pair of rows, three of them above, and two below the spiracles. The mature larvae are rather stout, cylindrical, tapering forward a little on the thoracic segments; the body is furnished with stout, tapering, bluntly tipped spines, each supplied with many aculiferous conical wartlets and arranged in a median dorsal series and four pair of lateral rows, two above and two below the spiracles. The chrysalids are well rounded and rather elongated with somewhat prominent wing thecae and frequent series of small conical tubercles arranged in longitudinal series; they are pale, brownish yellow, spotted and blotched with black.

EXCURSUS XXII.—THE HIBERNATION OF CATERPILLARS.

And, though a worm when he was lost,
Or caterpillar at the most,
When next we see him, wings he wears,
And in papilio pomp appears:
Becomes oviparous; supplies
With future worms and future flies
The next ensuing year—and dies!

COWPER.

CERTAINLY a quarter, not unlikely one-half of our butterflies survive the winter as caterpillars; and in the larger part of these the existence of the species depends upon their power of survival in this condition. Most of them pass the winter partly grown; some, as the species of *Thanaos* and

Pholisora, fully grown, partaking of no further nourishment when the winter is passed, but changing to chrysalis almost or actually before their food plant puts forth its leaves in the spring. Others still, and among these are most *Satyrinae* and *Argynnidi*, winter as young larvae just hatched from the egg, generally, perhaps always in New England, before they have touched a morsel of vegetable food, though their natural food-plant, upon which they were born, still offers sufficiently tender leaves. Of the species represented in this last category, some are not wholly dependent upon the survival of these delicate creatures, but accompanying them are half grown caterpillars of a preceding brood; this is especially the case with *Brenthis*. Of those that pass the winter half grown, we may specify *Cissia*, *Basilarchia*, *Brenthis*, all New England *Melitaeidi*, probably the species of *Eurymus*, and not improbably most of the *Pamphilidi*, of whose complete transformations we know far too little.

The most surprising fact we find here is the hibernation of young caterpillars just born. As they eat nothing, one would think they might at least have had the protection of the egg-shell and wintered within the egg; but in the cases in point, *Satyrinae* and *Argynnidi*, the eggs are naturally laid upon the leaves of plants which die down in the winter. Nevertheless it has been thought that in natural conditions, as has been known to occur in artificial, the caterpillar may sometimes not emerge from the egg until spring. I suspect that the caterpillars may be fully formed in the case of those other butterflies which hibernate in the egg state, such as some *Theclidi* and *Chrysophanidi*; for with many of these the eggs are laid in midsummer and the caterpillars do not emerge until early spring. The occasional appearance in these species of an autumn butterfly, however, indicates that in some exceptional instances an egg may hatch and the caterpillar grow to maturity the same year.

Hibernation at this tender age is all the more surprising from the fact, known only too well to everyone who has attempted to raise butterflies from the egg, that the greatest mortality exists among caterpillars in the first stage of existence, whether from natural causes or from the attacks of enemies, and also because in no case do these apparently helpless little creatures, generally but two or three millimetres long, construct any sort of a nest or retreat for their common or individual protection. They merely seek hiding places separately in curled leaves, in the ground, in crevices of bark and similar spots, where they are certainly not out of the way of mites and ants. Neither have they any appendages which are not shared with other juvenile caterpillars which do not hibernate. Yet there is no evidence from any poverty of butterflies in these groups that they do not retain as good a hold upon the fauna as those species which do not pass what would seem to be so perilous a winter. On the contrary, our *Satyrids* and *Argynnids* are plenty enough on the wing.

With few exceptions, such as *Cissia*, *Eurymus* and some *Melitaeidi*, all other hibernating caterpillars pass the winter in some sort of a nest. Most of them, separately or collectively, in one which has already given them protection during their partially completed larval life, but generally specially strengthened or enlarged for the purpose and almost always with all approaches closely sealed. The species of *Basilarchia* are the only ones among New England butterflies which construct hibernacula properly speaking, i. e., nests for the special purpose of wintering in them, and which they use at no other time. Here each individual makes for itself its separate nest. *Euphydryas*, however, alters and strengthens its social nest for the winter to such an extent that its appearance is then quite different, and in the centre, as the nest contracts with the withering of the leaves, the caterpillars are crowded together into almost a solid mass. The other larger caterpillars which make no nest probably seek merely some cranny upon or near the ground wherein to lie concealed during the winter. We find, therefore, no little variety among our native butterflies even in such an apparently simple matter as the hibernation of the caterpillar.

*** Some facts concerning the hibernation of the caterpillars of European butterflies will be found collected in Prittwitz's paper, heretofore alluded to (*Stett. ent. zeit.*, xxii: 191).

EUPHYDRYAS PHAETON.—The Baltimore.

[The Baltimore (Scudder); Baltimore fritillary (Gosse): red-bordered butterfly (Maynard); *Phaeton melitey* (Emmons); the black *Melitaea* (Ross).]

Danaus festivus phaeton Drury, *Ill. nat. hist.*, i: 42-43, pl. 21, figs. 3, 4 (1770).

Papilio phaeton Fabr., *Syst. ent.*, 481 (1775);—Cram., *Pap. exot.*, iii: 2, pl. 193, figs. C. D. (1782);—Herbst, *Natursyst. ins. schmett.*, vi: 111-112, pl. 142, figs. 3-4 (1793).

Melitaea phaeton Boisd.-LeC., *Lép. Am. sept.*, 167, pl. 47, figs. 1-2 (1833);—Boisd., *Spec. gén. Lép.*, i, pl. 11, fig. 3 (1836);—Doubl., *Trans. Linn. soc. Lond.*, xix, pl. 42, fig. 9b (1845);—Emm., *Agric. N. Y.*, v: 212, pl. 43, figs. 4, 7 (1854);—Harr., *Ins. inj. veg.*, 3d ed., 288, fig. 115 (1862);—Morr., *Syn. Lep. N. Amer.*, 50 (1862);—Lintn., *Rep. st. cab. nat. hist. N. Y.*, xxiii: 154-157 (1872);—Edw., *Butt. N. A.*, ii, pl. Mel. 1 (1875); *Papilio*, iv: 63-70 (1884);—Middl., *Rep. ins. Ill.*, x: 83 (1881);—

Fern., *Butt. Me.*, 45-46, fig. 16 (1884);—Grub., *Jen. zeitschr. naturw.*, xvii: 476-477, pl. 8, figs. 25-27 (1884); *Papilio*, iv: 89-90, pl. 3, figs. 25-26 (1884);—French, *Butt. east. U. S.*, 168-170, figs. 44-47 (1886);—Mayn., *Butt. N. E.*, 29-30, pl. 4, figs. 35, 35a (1886).

Euphydryas phaeton Scudd., *Syst. rev. Am. butt.*, 27 (1872).

Melitaea phaeton Herr.-Schaeff., *Prodr. syst. Lep.*, i: 79 (1865).

Melitaea phaetanea Hübn., *Verz. schmett.*, 28 (1816).

Argynnis phaetontea God., *Encycl. méth.*, ix: 256, 283-289, pl. 38, figs. 3, 3 bis (1819).

Figured by Glover, *Ill. N. A. Lep.*, pl. 22, fig. 6 (3 figs.); pl. 30, fig. 6?, ined.

A butterfly blundering by,—

And that is July!

MATTHEWS.—*July in the West.*

Imago (5:2; 12:2). Head covered rather thickly with short, black or brownish black hairs, slightly tinged with olivaceous, with a few yellowish hairs next the outer base of the antennae in front, a minute, lunate patch of yellow hairs at the back of the head, directly behind each antenna, opening toward the opposite one, and, occasionally, a few scattered yellowish scales down the front; a narrow patch of yellowish white scales, broadening beneath, along the inferior half of the hinder border of the eye.

Palpi reddish orange, lighter than the orange parts of the wings, and above, where appressed to the front, as well as on the inner side of the basal joint, furnished with a few very short yellowish hairs. Antennae black, nearly naked, with a few pale yellowish scales externally above on the basal half of the joints, especially on the basal half of the stalk, the basal four or five joints of the club luteo-fuscous. Tongue dull orange, slightly infuscated excepting at the base and extreme tip; papillae (61:43) situated only on the narrowed apex of the tongue, on the middle of the under surface of each maxilla, just not touching each other, the basal ones, figured on the plate, sub-cylindrical, five or six times longer than broad, the apical round-oval, the apical cup large and partly lateral, with a cylindrical, bluntly pointed filament, fully as long as the width of the basal papillae.

Thorax covered above with black or brownish black hairs, slightly tinged with olivaceous, the hinder part of each of the prothoracic lobes with a few sparse, pale greenish yellow hairs; beneath with short, brownish black hairs mingled with a few grayish yellow hairs and with a longitudinal dash of pale yellow scales next the base of each wing, and a small roundish one in the middle of the side of the prothorax. Fore legs dark reddish orange, the femora considerably flecked with fuscous; middle and hind legs dark reddish orange, the tibiae above with a yellowish tinge, and below with scattered pale yellowish scales, the tarsi slightly infuscated. Spines orange luteous; spurs blackish, tipped with dingy orange; claws and paronychia blackish, the former with the apical half dusky orange; pulvillus blackish fuscous.

Wings above blackish brown, marked with dark reddish orange and very pale straw yellow. Costal border of the *fore wings* tinged with reddish at the extreme base, with an orange spot in the middle of the cell just above the first divarication of the median nervure; it is irregular and variable in shape, about half as broad as the cell, and not infrequently divided in the middle longitudinally; another similar, although generally smaller and more frequently divided spot is found at the tip of the cell; midway between these spots, upon the lower border of the cell, and not infrequently also upon the upper border of the same, is a roundish or subtriangular, generally small, yellowish spot; all these spots, and especially the yellow ones, are occasionally obliterated; close to the outer margin of the wing is a series of eight orange, roundish or quadrate spots, sometimes trigonal, the base outwards, one in each of the interspaces above the submedian nervure, of nearly equal size, but the lower ones generally broader than long, while the upper ones are longer than broad; following these interiorly, and generally separated from them a very little more widely than they from the outer margin, is a sinuous row of pale straw yellow spots in the same interspaces, transverse and linear sublunate in the ♂, roundish or trigono-sublunate in the ♀, in both sexes approaching the outer border most closely in the subcosto-median interspace. At about an interspace's distance within is another series of similarly colored spots in the same interspaces, more sinuous than the previous, but nearly parallel to it; the spots are larger and more distinct than in the previous row, particularly in the ♂, and are roundish or longitudinally subovate; the next to the lower one is about in the centre of the lower median interspace. At a similar distance within this series is another imperfect series, still more sinuous, but generally obsolete on the lower half of the wing, particularly in the ♂, the upper two spots reduced to mere dashes, the succeeding three as large as those in the previous row, but with ill-defined borders, those below, when present, ill-defined and broken up; midway between this row and the outer orange spot of the cell is a transverse series of similar vague, often obsolescent pale straw yellow spots, generally trigonal and longitudinal, situated in the subcosto-median and succeeding superior interspaces. Fringe black, interrupted rather broadly, sometimes abruptly, on the outer half at the interspaces with pale straw yellow. *Hind wings* with the markings of the under surface appearing above, to a greater or less extent, upon the basal half of the wing. In the subcosto-median interspace just beside the last divarication of the subcostal, and very seldom also upon the opposite side of the last subcostal nervule, a slight, often obsolete orange spot; when it is present, a similar one is generally to be found in the costo-subcostal interspace just above the

first divarication of the subcostal. Next the outer border, and only separated from it by a thread of black, is a series of eight very large orange spots in their interspaces, their interior edges rounded off or subangular, as broad as long, separated from each other distinctly by the black-edged nervules, the upper three less distinctly than the others and occasionally almost entirely coalescent; these spots are narrowly bordered interiorly with black, and followed by a curving row, parallel to the outer border, of straw yellow, medium sized lunules, separated from each other by about their own length, occurring in all the interspaces above the submedian, sometimes absent from the costo-subcostal interspace, generally divided in the medio-submedian, those in the lower subcostal and three lower interspaces more lunulate than the others; this series is followed by a bent row of roundish or ovate similarly colored spots in the same interspaces, crossing the middle of the outer half of the wing, that in the upper median interspace occurring in its centre; the spots are usually about two-fifths the width of the interspace they are in; the series is bent at the subcosto-median interspace, and the spots in the upper half are a little elongated in the direction of the interspaces; fringe black, interrupted rather broadly but not abruptly with white on its outer half in the interspaces.

Beneath, the colors are a little brighter than above and in general the markings are the same. In the *fore wings* the submarginal series of orange spots becomes in each wing developed into a pretty broad band, fully as broad as the width of an interspace and broken by the distinct but slender blackish veins; a line of black separates the band from the outer border and it is margined within by a strongly crenate line, which separates it from the outer row of pale straw yellow spots, which here take on a strongly crescentic form, especially in the ♀, opening outward; the other yellow and orange spots are much as on the upper surface, only generally more distant, less frequently obsolescent on lower half of wing, and better developed and in general, and especially in the ♀, more quadrate; the orange spot of the middle of the cell is not infrequently accompanied by a satellite just below the median nervure, next its inner lower angle; fringe as above. In the *hind wings* the submarginal series of orange spots resembles that of the fore wings except that the inner black margin is still more strongly crenate, often, and especially in the middle half of the wing, approaching close to the outer border; the yellow spots of the outer row are much larger than above, only separated from the orange spots by the black bordering of the latter and very strongly crescentic, more so than on the fore wings; this row is followed by another series of yellow spots, the nearly exact counterparts of those of the upper surface; but within these, instead of being uniformly dark, there are further series of spots: in the first place there is a double series of not very large subquadrate, frequently slightly curving, yellow spots, parallel to the row just described, one in each of the interspaces; that of the inner row which occurs in the upper median interspace occupies nearly its extreme base, and that of the outer row in same interspace lies midway between it and the row beyond; a little distance within this inner series is an irregular, transverse, orange band, varying considerably in breadth, but usually about as broad as the submarginal band of same color, its inner margin generally just occupying the outer edge of the cell; it is frequently interrupted at the principal nervures and is made up first of a quadrate, slightly curving spot, its inner lower angle produced inward along the subcostal nervule, crossing the costo-subcostal interspace just above the first divarication of the subcostal; second, of a bent curving band, the upper half of which follows the upper outer extremity of the cell as far as the median nervure and then, not infrequently broken or diminished in size, bends at nearly right angles and tends directly toward the inner margin of the wing, but stops at the submedian; in the middle of the upper two-thirds of the cell is an orange spot of variable size and shape, not infrequently merged into the intra-mesial band, but generally separated by a black line; there is a similar, but generally larger and more or less roundish spot extending from the costal nervure to the costal margin and including the precostal nervure in its inner two-thirds; and a third, often divided by the submedian, situated between the median and internal, just before the middle of the cell; at opposite ends of

the spot in the middle of the cell and at equal distances from it are two not very large, roundish or trigonal, yellow spots, the outer generally the smaller and situated midway between the central orange spot and the apex of the cell; opposite the inner one, in the costo-subcostal interspace, is another one very similar to it; and in the medio-submedian is a fourth, usually transverse, lying midway between the intra-mesial band and the inner orange spot; occasionally an additional small, yellowish spot occurs above the costal nervure just beyond the orange spot; fringe as above.

Abdomen blackish brown, the posterior half with a lateral inferior series of transverse, sometimes nearly confluent, orange stripes, tipped superiorly with yellowish; there is also a dorsal and a lateral series of small, round, yellowish spots, the latter on all, the former on most, of the middle abdominal segments; beneath there is a similar but indistinct, though often confluent, ventral series of similar, but longitudinal spots, and the long inferior clothing of the terminal segment is orange. When denuded, the last segment of the male is scarcely shorter below than above, the appendages (34:3, 4) protruding but a short distance. Lateral processes of upper organ a little depressed, triangular, finely pointed. Clasps of equal length and breadth, the hinder border broadly rounded, its convexity covered interiorly by a lamella thickly studded with inturned bristles; the upper posterior angle slightly produced and directed inward; inferior basal process stout, directed backward and a little downward; interior tooth flat, triangular, very broad at the base and emitting two thorn-like blades, one shorter, compressed, arching inward, the other longer, appressed, curving longitudinally backward.

Measurements in millimetres. Length of tongue, 7-7.75 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	19.	23.	26.5	22.	29.25	31.
antennae.....	8.6	10.5	11.5	8.5	11.3	12.
hind tibiae and tarsi..	5.5	6.5	7.5	6.	7.5	8.25
fore tibiae and tarsi..	2.25	2.75	3.	2.5	3.4	3.25

Described from 14 ♂, 12 ♀.

Aberrations. E. P. SUPERBA (*Mel. phaeton ab. a superba* Strecker, Catal. Amer. Macrolep., 125). A single male specimen of this species has been taken near Brooklyn, Long Island, by Mr. G. D. Hulst, in which the "upper surface differs but little from the ordinary form, except that the two rows of submarginal white spots of secondaries are confluent, forming but one row of wedge-shaped marks with the points toward the base. Underneath the whole space, comprising the greater part of the wing, between the ferruginous basal patches and narrow margin of same color, is pure white, with the venation black." (Strecker.) This appears to be a case of partial suffusion.

E. P. PHAETHUSA (*Mel. phaethusa* Hulst, Bull. Brookl. ent. soc., iii: 77; iv, pl. 1, fig. 6). The same collector afterward took in the same place a melanic male of this species, which is the only case of the kind I have known. "The orange spots are wholly wanting on the upper surface of the wings; and beneath there are found only the one near the base, and, almost obsolete, the one along the costa near the base" (Hulst).

Egg (64:37). Nineteen ribs, .07 mm. apart, rather faint, most prominent above; surface covered with rather frequent shallow punctulations. Micropyle rosette made up of pentagonal or hexagonal cells, the inner and outer ones as broad as long, the others elongated, increasing in size from the centre outward, much broader outwardly, the longest cells being .42 mm. long, the broadest .034 mm. broad and the central ones .011 mm. in diameter. Color when first laid bright lemon yellow; in three days it becomes strongly tinged with brownish, and in two days more turns to a decided brown below; in another two days it becomes entirely purplish brown and shortly after deepens in color at the summit; when a little more than a fortnight old, the lower two-thirds begins to grow paler and in three or four days more it is entirely

pale below (some with a few purplish spots) and inky black above. Height, .8 mm.; greatest breadth, .6 mm.; breadth at summit, .27 mm.

Caterpillar. *First stage.* Head shining piceous with a very few rather short pale hairs; ocelli black; antennae pale obscured with fuscous; mouth parts dark fuscous. Body most delicately shagreened; the thoracic segments, particularly the first, and also the dorsum of the first, second, third, eighth and ninth abdominal segments obscure fuscous; rest of the body dull luteous, yellowish beneath; warts dark fuscous; hairs straight or curving, shining, pale. Legs pale obscured with fuscous; prolegs yellowish, the terminal pair blackish fuscous at base. Length of whole body, 1.52 mm.; breadth of body, .28 mm.; length of hairs, .19 mm.; breadth of head, .38 mm.

Second stage. Head shining piceous, with a few rather short, glistening hairs. Body pretty uniform dull luteous, the thoracic and terminal abdominal segments a little dusky; first thoracic segment with a dorsal, anterior, black shield from which the long hairs, arching over the head, take their rise. On some individuals faint indications of a dusky dorsal line can be seen. Spines black, furnished with several moderately long, straight hairs and terminating in a long, curved hair. Spiracles fuscous. Legs black; prolegs of the color of the body tipped with blackish fuscous. Length, 5.5 mm.; breadth, 1 mm.

The differences in the subsequent stages (79: 29, 30) are so trifling as not to merit a distinct description.

Last stage (75: 11). Head (79: 31) shining piceous, the sides and summit furnished with numerous minute black warts bearing black hairs. Antennae and mouth-parts black, the first joint of the former dirty white. Body deep orange or dull ferruginous brown tinged with orange, striped transversely with black; first and second and anterior half of the third thoracic segments black; each of the abdominal segments is margined at either end with black, and has a narrow, submarginal black band at its posterior extremity, connected above with the marginal line; the latero-dorsal spines are connected by a black line curving around behind the little advanced dorsal spine; the eighth and ninth abdominal segments are velvety black, the terminal pitchy black; there is a slender, black, infrastigmatal line; the body beneath is orange with a rather broad, black, ventral line and other black markings and a transverse median row of rather long, coarse hairs; each transverse orange stripe bears a row of slightly curving black hairs. Spines shining deep bluish black, the needles black. Spiracles black. Legs black, the first joint dirty white; prolegs dark orange, blackish externally, clothed with black hairs. Length, 25 mm.; breadth, 4.5 mm.; length of spines, 2 mm.; breadth of head, 2.1 mm.

Chrysalis (84: 7, 15, 16). Very pale bluish white, marked with pure velvety black and pale orange; ocellar ribbon black, enclosing an orange space between it and the antennae, marked with a few black punctures; antennae alternately black and white, the club black; vertex with two orange warts set outside of a black spot which passes midway down either side to the tongue; tongue black; legs orange, marked with black and with spots of brownish or burnt yellow; wings with the basal prominence orange, tipped with black and surrounded by the same, an orange spot at the base posteriorly, a series of irregular, black, orange bordered dashes and spots across the middle of the wing, the basal half of the inferior margin orange, a black dash at the tip and a series of black dots at the nervure tips. Thorax with a delicate black dorsal line; prothorax with a pair of central, subdorsal, black dots and along its posterior margin four equidistant black spots, the inner pair on the anterior margin of the mesothorax; the latter with a pair of central, subdorsal, black dots, behind which are two narrow, divergent, black dashes. Abdomen with a subdorsal series of transverse, slightly oblique, black dashes centrally placed; posterior to them and a little outside, a series of straight, transverse, black dashes; on the second and succeeding segments there is also a lateral row of circular black spots two on a segment, one placed anteriorly, the other posteriorly; behind the suprastigmatal warts there are on each segment two or three small, sometimes confluent, black spots; there is also a

stigmatal row of transverse black spots, similar in appearance to the spiracles, situated posteriorly. Ventral surface marked rather heavily with black, margined with orange; a lateroventral series of small, transverse, orange spots, two on a segment and on either side a row of black spots. Tubercles of thorax and abdomen orange, sometimes tipped with black or shining fuscous, and usually bordered at the base on the anterior and inner side with black; these basal black markings and the oblique, central, subdorsal dashes sometimes become confluent on the posterior segments and form tortuous, brace-like, black markings. Spiracles black. Cremaster black throughout excepting anteriorly, where it encloses a double orange spot. Length, 17.5 mm.; width at thorax, 6 mm.; width at base of abdomen, 5.5 mm.; height of thorax, 6 mm.; height of middle of body, 6.5 mm.

Distribution (22:7). This butterfly is a member of the Alleghanian and Canadian faunas, but being eminently local in its habits has not yet been found over the whole extent of the country which it probably occupies; it is abundant along the Atlantic coast and apparently equally so inland; but its western limits are as yet doubtful. Dr. Kirtland reports it from several points in Ohio and Mr. Harrington says it is common in southern Michigan. The Museum of the University of Michigan also contains specimens taken in that state. Mr. Worthington and Dr. Levette record it from Illinois, and I saw specimens in the Chicago Academy's Museum. Dr. Hoy says it is "rather rare" in Wisconsin, and Professor Parker that it occurs in Iowa; single captures have even been made by Dr. Dawson at the Lake of the Woods and by Professor Snow in eastern Kansas. Southwardly it is common in the neighborhood of Philadelphia (Blake), Maryland (Uhler) and West Virginia (Edwards), and Edwards also reports it from Kentucky; to the north it occurs in Quebec "rare" (Bowles), Montreal (Caulfield, Pearson), Ottawa "common" (Billings, Fletcher), and at Nepigon, north of Lake Superior (Fletcher). It has been reported from Nova Scotia and New Brunswick. The anonymous statement (Field and forest, iii: 132) that it was once taken on Christmas day in Denton County, Texas, is unquestionably false.

In New England it is found abundantly everywhere from the heart of the White Mountains to the lower portion of the Connecticut River valley; but owing to its local habits it is ordinarily esteemed rare. It has not been reported further east than Hallowell (Miss Wadsworth), Waterville (Hamlin) and Orono (Fernald) in Maine, in all which places it is accounted rare.

Localization. It occurs only in bogs or moist and shady meadows of small extent seldom frequented by the aurelian, and is often so limited in its range as scarcely to be seen one hundred yards from a spot where it swarms. Mr. Emery writes that he has found it in greatest abundance near Springfield, Mass., on a spot less than an acre in extent, and another locality which he has visited for several years in search of it will not measure more than three rods by ten. Dr. Minot has found all his specimens in Quincy, Mass., in a field about two acres in extent. Indeed one might

collect butterflies for years and consider phaeton the rarest of the tribe while multitudes sport in security within a few rods of the beaten track. Mr. Lintner's experience is the same; he remarks, "This species presents a notable illustration of the localization of certain insects. . . While this prolific collecting field [Center], as circumscribed by almost fruitless explorations of adjacent territory, embraces a tract of about three-fourths of a mile square, the phaeton habitat proper has a radius of but one-eighth of a mile, with an occasional elliptical extension to one-fourth of a mile in diameter. Its central point is the extension of a swamp over a seldom traveled road, where a few inches of water is found throughout the summer. . . . Beyond these limits the species has not been observed, during five years of frequent visits to this locality by Mr. Peck and Mr. Meske. . . . I have not met with it at Scoharie, nor in the neighborhood of Albany except at Center, although its favorite food plant is of common occurrence in this vicinity."

At the same time it would appear from certain observations that occasionally (probably when their numbers are so great as to suggest a scarcity of food-supply for their progeny) they are found outside their usual haunts and in considerable numbers, surprising those who have not before seen them with their fine contrasting colors. Thus Mr. Bates of South Abington, writing in 1877, says, "For two or three years past I have searched in vain throughout this locality for phaeton, but this season I have taken all that I wanted"; and Professor Parker, formerly of Amherst, where the species is generally accounted rare, says that contrary to usual reports it was not confined to a small locality but became rather common in several directions from the village.

Oviposition. Mr. C. A. Emery, of Springfield, was so fortunate as to observe a female of this species upon a leaf of *Chelone*; examining the leaf he discovered a patch of eggs upon the middle of the under surface, closely packed beside the midrib, arranged in three layers, all of irregular outline; the basal layer was 8.5 mm. long and 5.5 mm. broad; this formed the floor of the second, which was similar in appearance but smaller, and the uppermost measured 6 mm. long and 3.5 mm. in breadth. Without removing the layers it was of course impossible to count the eggs; but they were estimated to number about two hundred, and it is not at all improbable that the female may have been disturbed before completing her task. Mr. Edwards, who has since obtained them more than once, says that the clusters (64:43) number from one hundred to four hundred eggs, and that they are laid on the under surface. In one instance there were five layers. *Euvanessa*, *Eugonia*, *Aglaïs*, *Phyciodes* and *Cinclidia* also lay their eggs in clusters, and probably *Hamadryas* does the same, but no other butterfly is known to deposit such irregular masses. The eggs hatch in nineteen or twenty days.

Food plant. The proper food plant of the caterpillar is the snake head, *Chelone glabra* Linn. It is, however, found on other Scrophulariaceae, such as *Mimulus ringens* Linn. (Troxley) and *Gerardia pedicularia* Linn. (Edwards); it is also especially fond of *Lonicera ciliata* Muhl., particularly in the spring, and, according to Glover, occurs on *Virburnum dentatum*, these two last plants being Caprifoliaceae. In confinement it has been raised on other species of *Lonicera* and on plantain (Miss Morton, Bruce), the latter a plant allied to the Scrophulariaceae, and Mr. Trouvelot assures me that it will then eat black currant, but in this I suspect he is mistaken. It has also been observed upon other plants, such as *Aster*, *Corylus*, barberry (*Berberis*), and even on ferns, grasses and flags. So, too, Messrs. Edwards and Mead have found its nest on *Solidago*, *Vernonia*, *Clematis* and *Rubus*; but *in none of these cases was the insect feeding*, and as all these plants were growing in the immediate vicinity of *Chelone*, we may lay the presence of the caterpillar to the account of its roving disposition. In this way we may explain the mistaken statement of Mr. Bruce (*Papilio*, i: 188) that the caterpillars found by him "fed on almost any low plant or shrub, many of them on *Typha latifolia* (!), but they appeared to prefer *Lonicera*." The specimen I took on the barberry changed to chrysalis the following day and had, undoubtedly, sought the plant only for transformation. Mr. Edwards writing in 1884 says that *Actinomeris* is one of the food plants, but does not include it in his list of the food plants in 1885. In the White Mountains I found the hibernating larvae exclusively on *Lonicera* in the spring.

Habits of the caterpillar. The hatching caterpillar eats an opening around the summit of the egg, sometimes leaving the outer portion of the ribs until the last; the lid thus formed is thrust off, and the caterpillar, emerging, partially devours the deserted shell; it then moves briskly about with its companions, and before eating they prepare a small web upon the under surface of the leaf; this web is very thin and covers little more than a spot sufficiently large for feeding. They eat the parenchyma only, and the opposite upper surface turns black in consequence. They feed in rows, those of each row simultaneously moving the head and anterior part of the body from side to side; they frequently wander uneasily and rapidly from the web, but always return again; indeed they retain this restless habit throughout life, and according to Mr. Emery, to whom I am indebted for most of these facts,* occur more frequently off than on the snake head. After the first moult they eat holes in the side of the

*These observations were not made without difficulty. Mr. Emery writes enthusiastically of his first discovery after three fruitless expeditions:—"At noon I took the cars to Holyoke and walked four miles over the hills to the swamp, spent an hour wading ankle-

deep in mud and ice-cold water, with a drizzling rain to cheer me on; but I found the animals and forgot the wet feet, the wet back, the four miles between me and Holyoke, in the satisfaction of having accomplished my object."

leaves, generally near the middle, always reaching the midrib. Before their first moult, however, and indeed within about twenty-four hours of their birth, their manner of life changes. They no longer feed on an open web, but bend the leaf upon itself into a "knot," as Mr. Edwards calls it, or construct a covering web, usually on the topmost leaves of the stem, and feed on the green leaves enclosed; as these are consumed the web is extended down the stem, covering fresh leaves. The first moult takes place in West Virginia in six days, according to Mr. Edwards (from whom a few of the previous facts, and most of the remaining statements concerning the caterpillar are taken bodily) and the second at about the same time thereafter. As they grow they enlarge the web, all working for the common good. Especially as each moult approaches, all wanderers come home, and the web is made tight, and into it they retire and pass the moult, which over, the web is extended again. If at any time the web is injured by storms, the caterpillars forthwith set at work repairing, and do not rest, whether it rains or shines, till the work is done. Mr. Edwards thinks they have a prevision of storms, and all hands may be seen working at their dwelling industriously, strengthening it here and there, even when the sky is clear, and there appears no reason for work. Thus Mr. Edwards relates that a June day "began with showers, but cleared up in the afternoon, and all of a sudden the whole colony was found actively at work. I entered in my note-book that I believed the unusual stir was owing to a change of weather for the worse, which these creatures had a prevision of, for I had noticed some years ago that before a storm great efforts were made by phaeton larvae to put the webs in order." In this instance, however, the rain did not come for two days. In case of damage to the nest it is at once repaired when sunshine returns. A few holes are left for ingress and egress. To this nest they retire for the night and for moulting, feeding only by day, when they extend the webs over new feeding ground, though many are found wandering beyond its protection.

The first nests built are slight and quite transparent, the warp composed of long, regular and colorless threads, which run from the stem to the middle of the next leaves below, and are bound together by innumerable cross threads, which take no regularity whatever. Each succeeding nest is more securely built, till finally, when the third moult approaches, nine or ten days after the second, the web is often as large as a man's open hand, made of closely woven silk, of more than one coat, and capable of resisting storms and even the wear and tear of winter. Mr. Edwards found one eleven by four inches at its extremes. Within this more compact web they pass their third moult, and then remain hibernating along with their cast-off clothing. Three such nests were found by Mr. Emery in September, 1869. He kept one in a jar in a partially warmed room until at least the middle of November, and the caterpillars were then

alive and quiet; one which he sent me (82:3) was of a regular, compressed, ovoid form, about the size of a pigeon's egg, and composed of leaves and fruit of *Chelone*, securely bound together by a silken web; most of the leaves were already dead, and all were covered with web, and the interspaces so filled with silk that the whole outer surface was smooth and uniform. The nest was soft and flexible throughout, the web delicate, allowing the parts within to be seen, but very close and even. On opening the nest it was found very compact, formed upon the drooping head of the plant, which was partially distended as it were by the apical leaves; in various parts of the nest there were several oblong holes or passages, about the size of the caterpillars, which measured from 4–9 mm. in length. There was a great deal of filth in the nest, and it was also tenanted by the very lively caterpillar of a moth.

Mr. Edwards describes as follows the largest nest seen by him while it was under construction. It was—

Long and narrow, tapering at either end, about three inches broad in the middle, and so thick and closely woven as to conceal the interior. For egress while at work, two somewhat tubular openings were left on the middle of one side, and the threads about these were doubled. To support this large web the upper part of a stem of swamp grass . . . was bent down, and its broad and spreading leaves were bound over the surface, and this with the stem of *Chelone* was stiff enough to resist the wind. After the larvae had ceased work and finally retired within the web, a slight covering was spun across the outlets, sufficient, evidently, to throw off water and to keep out spiders. . . . Six weeks later the webs were found to be bleached white, and were weather-worn and considerably shrunken; often distorted, too, by the growth of the plants. The effect of the shrinkage was to compress the larvae into a hard, compact mass.

The caterpillars make some selection in constructing their nests, since they are not always found upon *Chelone*, which is an annual, and when using that as a basis generally interweave the outlying parts of the surrounding herbage. Here, then, they take up their winter quarters—with us in the latter part of August or early in September, but further south, where Mr. Edwards has observed them in West Virginia, about the middle of July, when there is abundant season for a second brood. Yet whether in the White Mountains or Virginia, to bed they go when the third moult is past. Yet in Virginia their condition is not then one of torpidity or even of lethargy, for when disturbed there is an immediate and general movement. Mr. Edwards removed some to a young plant of *Chelone*, tempting them with their choicest food, “but they showed no disposition to feed nor to construct another web. They ran over the leaves for a few hours, till the whole plant had been thoroughly explored and then left it, betaking themselves to the grass.” They evidently wished to be let alone.

In the spring, all is changed. They forsake their web, and though still gregarious to a limited extent wander ceaselessly about, swarming over *Lonicera* and other plants, seeking only the concealment of dead leaves

and the under surface of sticks on the ground in their moultings or during storms ; but at other times always exposed to full view, when their brilliant color and active movements make them very conspicuous ; neither do they seek protection by feeding at night. Their only sensitiveness to danger is shown by the readiness with which they coil up and drop to the ground, when the plant on which they are feeding is jarred.

In New England, the caterpillar moults once only in the spring before the final change to chrysalis ; Mr. Edwards, however, states that in the south it moults twice ; moreover, he remarks that on opening some of the wintering webs, presumably in the autumn, he invariably found a small percentage of larvae which had not passed the third moult. If this condition existed through the winter, there would of course be one additional change of skin for those which had been backward the previous year. All that I have seen of them leads me to the belief that there is but a single spring moult in New England before the final change.

The caterpillars wander vigorously for pupation, hurrying as if their lives depended on their reaching somewhere before the final change. Yet somehow they do not seem thereby to disperse widely, for several may be found hanging on the same bush or fence rail and Mr. Edwards once had half a dozen brought him ‘suspended by one button like a string of fish.’

Life history. The insect is single brooded ; the hibernating caterpillars attain their growth in May and the chrysalids hang for from fourteen to eighteen days, whether in New England or Virginia ; the earliest butterflies appear in the southernmost part of New England at the very end of May or in the first days of June ; about Boston they are seldom seen before the 12th of June and they become abundant a very few days after their first appearance, although they continue for some time to emerge from the chrysalis. Mr. Emery even reports taking one of the hibernating caterpillars about Springfield as late as July 4. On the other hand I once had a larva found near Boston change to chrysalis as early as May 19 ; it was, however, parasitized ; yet Mr. Bruce says he took parasitized larvae at Brockport, New York, on June 1, and that they ‘kept on feeding two weeks longer than the healthy subjects.’ In the White Mountain region they are not much later than about Boston, for I have found them in abundance on June 17. Toward the southern extremity of their range, according to Mr. Edwards, they make their advent by the 18th or 19th of May. They are on the wing usually about four weeks, and worn specimens may be found a few days longer. By the 15th or 20th of July they have usually disappeared even in the northern parts of New England. They appear to lay their eggs about three weeks after their first appearance,—between the 5th and 15th of July in the latitude of Boston. These hatch in nineteen or twenty days, the caterpillars grow very slowly (Edwards speaks of their changes in West Virginia as rapid), and

in their fourth stage in the latter part of August or early in September begin to hibernate.* They arouse with the first breath of spring and in continued good weather a week of feeding on the succulent leaves of the young *Lonicera* or *Chelone* must be sufficient to mature them.

The statement in Drury's *Exotic entomology* that this butterfly is "taken in June and September, whence probably two broods a year," is quite erroneous. It is never or very rarely taken after the first of August. I say very rarely, for it is not impossible that an occasional individual chrysalis may fail to give forth its inmate until an exceptionally late period. Two late appearances are on record. Once when Mr. Billings of Ottawa, Canada, saw one flying in August or September; and again when Dr. Levette saw one near Galena, Ill., during the second week in August; perhaps in Drury's statement we have the ghost of a third.

Habits of the butterfly. The haunts of this insect have been already discussed in treating of its localization. Its flight is rather slow and heavy, ordinarily about two feet from the ground. It is fond of alighting to suck the juices of red clover and white weed, but prefers generally the leaves of shrubs or of ferns or even the ground; when at rest upon a vertical surface, the wings are shut and the costal borders of the fore and hind wings are brought in contact; the antennae are parallel at the base, but diverge beyond at an angle of from 50° to 55° , their tips being 10 mm. apart; they are raised so as to be nearly parallel with the costal borders of the wings.

According to Mr. Edwards, the butterflies are not touched by birds "probably having some quality obnoxious to smell or taste, and the caterpillars seem to have a similar immunity." Caterpillars as spinous as these are rarely attacked, and it would seem as if so sluggish a butterfly would soon have been exterminated by birds, did it not possess some obnoxious character, for it is, I think, the most sluggish butterfly we have.

Parasites. Yet the caterpillar, notwithstanding the colors which may warn off intruding birds, is subject to other foes, for it is attacked by large numbers of an unknown pteromalid fly which does not destroy its victim until the latter has changed to a chrysalis; in this chrysalis the parasites remain the greater part of the year, sometimes appearing on the wing as late as the last of June; all chrysalids which hang through the winter are parasitized. Hence it is possible that the parasite requires two years to complete its transformation, passing one winter in the chrysalis of its victim, the next in the young larvae of the succeeding brood of butterflies.

It was perhaps this foe the young larvae were fearing which Mr. Edwards once saw "in a state of great agitation . . . running about wildly and throwing their heads and two-thirds the body in a jerking way from

*Mr. Holmes Hinckley is very sure that caterpillars which he observed at the White Mountains, both indoors and out, ate nothing

after the second week of August and is "inclined to believe they stopped eating a week earlier." See also *Psyche*, v: 54.

right to left, all in the same manner and like so many automata. The cause of the alarm seemed to be a small crimson ichneumon fly . . . which alighted on one of the leaves" near by.

Endurance. Mr. Edwards regards the caterpillars as very tenacious of life, as some that had undergone a submersion in water of five hours duration revived and passed successfully through their transformations. But he points out one case of their entire extermination in one locality by the long continued submersion of the swamp in which the caterpillars lived, by a flood in the Kanawha River. For six years not a phaeton was to be found there, so he deliberately restocked it by turning loose in it some two dozen butterflies he had reared, and his experiment was an immediate success. The butterfly itself is also in a sullen, passive way more enduring than most species as is proved by its requiring more violent means to extinguish life.

Mr. Edwards has also experimented with the action of cold on the chrysalids, thirty-nine of them having been placed on ice at various periods from two to thirty-four hours after pupation and exposed for from ten to twenty-seven days. No result except a retardation in the emergence of the butterfly followed, the length of the chrysalis stage after removal from the ice being the same as after pupation normally. But no suffusion or other variation in the imago was induced.

Desiderata. Though our knowledge of this insect is comparatively complete, there are still some obscure points. Are all the eggs of one butterfly normally laid in a single patch? Are there two spring moultings in the south and only one in the north? What meaning shall be attached to the occasional appearance of single butterflies on the wing long after the normal period? Perhaps experimentation with cold on caterpillars or chrysalis may throw light on this point. What is the cause of the localization of the butterfly? Is it simply connected with the stations of its food plant, or is it actually absent from places where it might be expected and where *Chelone* and *Lonicera* are abundant? The parasite needs to be determined and the whole story of the relation of the parasite to the butterfly needs clearing up; a fuller description of the flight of the butterfly and more information concerning its western range are desirable.

LIST OF ILLUSTRATIONS.—*EUPHYDRYAS PHAETON*.

<i>Egg.</i>	<i>Imago.</i>
Pl. 64, fig. 37. Colored.	Pl. 5, fig. 2. Female, both surfaces.
43. Cluster of eggs.	12: 2. Both surfaces.
<i>Caterpillar.</i>	34: 3, 4. Male abdominal appendages.
Pl. 75, fig. 11. Mature caterpillar.	39: 1. Neuration.
79: 29-31. Front views of head, stages iii-v.	54: 5. Side view of head and appendages enlarged, with details of the structure of the legs.
82: 3. Winter nest.	61: 43. Papilla of tongue.
<i>Chrysalis.</i>	<i>General.</i>
Pl. 84, fig. 7. Side view.	Pl. 22, fig. 7. Distribution in North America.
15. Same in outline.	
16. Dorsal view in outline.	

SUBFAMILY EUPLOEINAE.

Danai festivi Linn.; Festivi Fabr.; Festiva Grav.	Danaides Boisd.; Danaites Blanch.-Brullé;
Tribuni Herbst.	Danaidae Dup.; Danainae Bates; Danaina
Limnades Hübner.	Herr.-Schaeff.; Danaiden + Neotropiden
Heliconidae (pars) Swains.; Heliconiidae	Schaatz.
(pars) Westw.	Euploeinae Moore.
	Idea Koch.

With soft
And aimless flutter, painted butterflies
Hung drifting here and there like floating leaves,
Or rested on a weed to spread their wings.

STORY.—*Ginevra da Siena.*

Imago. Butterflies of large size. Head large; front swollen a little, protuberant beneath. Antennae inserted on the summit, not in a pit, consisting of from forty to forty-five joints, moderately stout, naked, nearly as long as the abdomen, the club pretty long and not very broad, drooping; palpi stout, tufted with hairs, mostly arranged in a vertical plane.

Thorax stout, rather compressed, upper surface greatly and pretty uniformly vaulted; anterior sides of the mesoscutellum considerably hollowed, only their interior inner halves projecting into the mesoscutum and forming thereby much less than a right angle; posterior border of mesoscutellum strongly curved, forming almost a rounded right angle. Metascutellum inconspicuous, formed of a triangular piece, mostly facing backward, not greatly broader than high, appearing above as crowded between the metascuta and as broad only as one-quarter the width between the posterior angles of the mesoscutum; metascuta well developed, tumid.

Fore wings greatly produced at the upper outer angle and generally more or less excised along the middle of the outer border, the tip rounded and the outer border never angulated, except, occasionally, in a very slight degree. Costal nervure terminating a little beyond the middle of the front border; subcostal nervules varying in their origin; usually at least one of the superior nervules is emitted before the tip of the cell; the inferior nervules arise much as in the previous sub-family; cell at least half, and usually more than half the length of the wing, closed completely; first branch of the median nervure sometimes arising at the middle, but usually at some distance beyond the middle of the cell; last branch curving at its base pretty strongly, often abruptly, toward the subcostal nervules; internal nervure, when present, very slender and running into the submedian nervure close to the base.

Hind wings rounded, much smaller than the fore wings, the disparity in length being greater than in any other subfamily; margin regular, tailless, the inner margin sometimes guttered. Costal nervure terminating, generally, near the middle of the costal border but sometimes reaching the outer angle; lower subcostal nervule curving toward the median; cell closed by a strong vein, which connects the curving portion of the last subcostal nervule with a similar portion of the last median nervule, and has a variable direction; median nervules nearly equidistant; the first one generally arising beyond the middle of the cell; last branch curving strongly or bent to receive the veinlet closing the cell; submedian nervure usually terminating at the outer border, sometimes at the anal angle; internal nervure usually terminating at the anal angle.

Fore legs greatly atrophied in the male, less so in the female; in the former, the tarsi consist of a nearly undivided joint, unarmed; in the female the tarsus ends abruptly but consists of several, though not the normal number of joints, each furnished at tip beneath with a pair of short spurs; claws wanting; on the other legs the claws are very large and long, not falciform, and both paronychial and pulvilli are absent.

The eighth abdominal segment of the male is prolonged at the sides so as to resem-

ble clasps and to protect an extensible finger of long hairs enclosed in a sheath: upper organ of appendages without lateral arms, small, the hook about as long as the centrum; clasps variable, generally much as in *Nymphalinae*.

Egg. Stout, truncato-fusiform, bluntly pointed at tip, with a great many longitudinal ribs and numerous distinct, transverse, raised lines. Laid singly, or sometimes (*Mechanitis* t. Müller) in small clusters.

Caterpillar at birth. Head not larger than the thoracic segments and smooth. Body cylindrical, not tapering, furnished with short tapering hairs, usually not so long as the segments, arising from minute papillae, arranged on either side of the body in four longitudinal rows above the spiracles, besides, on the abdominal segments, two rows below the spiracles.

Mature caterpillar. Head small, well rounded, nowhere protuberant, smooth, broadly and vertically banded. Body large, plump, cylindrical, naked, tapering anteriorly on the thoracic segments, banded conspicuously with numerous alternating, transverse, gaily colored stripes, naked, or a few of the segments bearing erect, slender, fleshy, laterodorsal filaments of greater or lesser length.

Chrysalis. Generally short and very stout, rounded, with very few projections; tapering very rapidly over the whole or posterior part of the abdomen to the long and slender cremaster. Head scarcely produced in front, the anterior curve of the body very high, the thorax and abdomen separated by a slight and broad hollowing; appendages of the head and thorax not raised in the slightest above the general curve of the body.

This subfamily is almost entirely confined to the equatorial regions of America and Asia, but very few genera, poorly represented in species, occurring outside these districts; the paleogeon forms belong, as a rule, to distinct genera from those found in the New World, and form a group apart from the neogeon genera as arranged by systematists. The single species described in this work, with one or two allies, form a striking exception to this rule, for, although originally peculiar to the New World and widely distributed therein, they belong to the Old World type. Indeed this is true of all the *North* American species. The species of *Euploeinae* are invariably very numerous in individuals on both continents and, as proved mainly by the researches of Messrs. Bates, Wallace, Fritz Müller and Trimen, are the objects of unconscious mimicry by other butterflies and by one another to an extraordinary extent. A very considerable table of such mimetic forms involving many species has been given by Moore (*Proc. zool. soc. Lond.*, 1883, 207).

These butterflies average far above the medium size and have rounded and somewhat elongated wings, on which ochreous, tawny or white markings contrast rather vividly with dark ground colors, although the basal color is not infrequently more or less orange, as in the species found in North America; the palpi and antennae are rather short, the abdomen of unusual length and the legs long and stout, the perfect ones furnished only with closely appressed scales; the integument of the body is tough and elastic. The male abdomen is furnished at tip with an extensile pencil of long, straight hairs, first described by Herbst and Jablonsky.

The flight of these butterflies is powerful and sustained, although generally rather slow. They often sail high in the air on expanded wing.

Wallace, who has had the opportunity of seeing them in their metropolis both in the Old World and the New says: "they frequent the most open situations, fly low and settle on herbaceous plants," which is certainly true of the New England species. The species are generally exceptionally numerous in individuals. Some are known to migrate.

The eggs are slender obconic, vertically ribbed and transversely striate, and are generally laid on the food plant singly, hatching in a few days. Gagliardi is probably wrong in saying that the European chrysippus lays in the ground at the foot of *Asclepias* (nella terra, e spesso a' piedi dell' asclepiade).

The caterpillars are stout, fleshy and cylindrical, tapering anteriorly; in the Old World type always, in the New World sometimes, two or more segments of the body are furnished above with a pair of long, slender, flexible, tapering filaments, forming a characteristic feature. According to Wood-Mason the anterior pair "are articulated and freely movable at the base and function as antennae" (Nicéville, Butt. Ind., i: 22); but there is certainly nothing which can be called articulation in our American species, though they are freely movable, and often palpitae in walking. The larvae are rapid eaters and feed, the Old World type, or *Limnoidi* (to which our New England species belongs) on *Asclepiadaceae*, the New World type, or *Ithomyidi* on *Solanaceae*. The transformations of several species are known but their history is still somewhat imperfect. They are on the wing throughout the year in the warmer parts of America, and pass through several successive broods, wintering farther north in the imago state.

The chrysalids are always suspended by the hinder extremity; they vary considerably in shape, but are generally plump and without sharply angular projections; they are usually green or yellow and marked with golden spots or streaks, and are rather irregular in the length of time during which they hang, varying from seven to twenty days according to the weather.

The position of this subfamily has been discussed on pages 113-114. A single genus and species occurs in our northern fauna.

ANOSIA HÜBNER.

Anosia Hübn., Verz. bek. schmett., 16 (1816).

Danaida Latr., Sonn. Buff., xiv: 103 (1805).

Danaus Latr., Gen. crust. ins., iv: 201 (1809).

Danaus God., Encycl. méth., ix: 172 (1819).

(Not *Danaus* Panzer 1801).

Type.—*Pap. plexippus* Linn.

A butterfly, with golden wings broad parted
Nestling a rose, convuls'd as though it smarted
With over pleasure.

KEATS.—*Sleep and Poetry.*

Imago (52:2; 62:1). Head (87:25) large, covered thickly with rather short hairs, longer around the base of the antennae. Front moderately full, thrust abruptly

forward at the sides, broadly and not greatly protuberant in the middle beneath, of about the breadth of the eyes, broader than high, the middle of the upper border projecting backward midway between the antennae, where it is separated from the vertex by a straight transverse line; the lower border rather abrupt, straight, the sides sloping a little to meet it. Vertex a little tumid, hollowed behind the antennae, projecting forward to meet the front, otherwise transverse, much broader than long; posterior edge slightly convex; upper border of the eye inconspicuously angulated opposite the middle of the vertex. Eyes large, full, smooth. Antennae inserted in the middle of the head, separated by nearly their own width and crowded close upon the border of the eye; scarcely as long as the abdomen, composed of forty-three or forty-four joints, the last ten or eleven forming a club, which slowly increases in size to nearly double the thickness of the stalk and in the last three joints tapers to a very bluntly rounded point; transversely circular, the club slightly depressed, the whole antenna, excepting near the base, delicately carinate along the under inner edge. Palpi stout, fully half as long again as the eye, the terminal more than one-third as long as the middle joint, profusely tufted beneath with short, rather coarse hairs, spreading a little beneath.

Prothoracic lobes not large but very full, globose, twice as broad as long or high, broadly rounded at either end. Patagia rather large, very broad, almost flat, the posterior lobe curved considerably, not twice as long as broad, scarcely diminishing in size, the tip broadly rounded.

Fore wings (38:2) very long and rather slender, greatly prolonged at the apex, so as to be about twice as long as broad, and presenting a somewhat triangular outline, of which the costal border is the broad base, and the other two margins the equal sides; costal border very broadly and regularly bowed, nearly straight for five-sixths its length, at the tip curved a little downward, forming, with the slightly and broadly sinuate outer margin, a well-rounded apex; the two halves of the outer border nearly straight and bent a very little; the inner border nearly straight, a little protuberant near the base, with the lower outer angle rounded. Second superior subcostal nervule originating directly opposite that of the first inferior branch; cell somewhat more than half as long as the wing (largest in the female), and almost four times as long as broad; first median nervule arising a little beyond the middle of the cell, the second midway between the origin of the first and the tip of the cell; internal nervure very minute.

Hind wings well rounded; the costal border suddenly and considerably protuberant at the very base, beyond, very broadly and regularly bowed; the outer border roundly arched above, without any angle at its union with the costal border, its lower half nearly straight, broadly bowed; the inner margin suddenly and greatly protuberant at the very base, forming rather more than a right angle with the part beyond, which is straight, or, next the base, scarcely incurved, the outer angle rounded; inner margin a little depressed to form a gutter, within a line from the base to the lower outer angle. In the male there is near the middle of the inner border of the lowest median nervule (which is sometimes deflected in its course to accommodate it) a pouch or pocket of membrane heavily clothed with scales (44:2, 3), open on the upper surface of the wing away from the nervule, and containing androconia of two patterns, one rod-like, the other spatulate and even-edged.

Fore legs small, cylindrical, hairless, the tibiae about half the length of the hind tibiae, or, in the female, slightly longer; fore tarsi less than half the length of the tibiae (♂), or about two-thirds their length (♀), either consisting of an apparently undivided, unarmed, uniform, cylindrical joint, tapering rapidly at the very tip to a blunt, conical apex (♂); or, taken together, are strongly compressed, expanding apically, the apex broadly rounded, and consisting of three joints, the outer two equal, the basal occupying three-fourths of the whole tarsus, each joint furnished at the extreme tip of the under surface with a pair of approximate, short, slender, equal, parallel spines, the last pair being exactly apical (♀). Middle tibiae slightly longer than hind tibiae; tibiae furnished on the inner side of the upper surface

with four or five short, not very slender, recumbent spines, and at the tip, on either side of the under surface, with a pair of long and rather slender, parallel, recumbent spurs; middle tibiae also furnished, just before the middle of the under surface, with a median carina of raised scales. First and fifth joints of the tarsi equal and largest, either of them as long as the others combined, which are also equal among themselves; the distal half of the basal joint and the three succeeding joints furnished beneath with a quadruple row of short, straight, undiverging spines, the apical ones much longer, rather stout, appressed, and delicately striate; apical joint similarly furnished, but all the spines are large and increase in size from either end toward the middle. Claws very long, compressed, scarcely divergent, bowed at base, straight beyond and curved a little downward at tip.

Sides of the eighth abdominal segment enormously developed in the male (33:24; 61:59), extending backward in the form of clasps, forming a slightly tumid plate, presenting its broader surface to the side, extending so far as to conceal all the genitalia, about as long as the segment itself, square, but with the posterior edge rather deeply excised, so as to leave the upper and lower angles projecting and bluntly pointed, the latter slightly incurved. Upper organ of the male appendages consisting of a pair of small, closely approximated, lateral plates, compressed together, united above, opening as by a split posteriorly; they are less corneous than the other parts and each consists of a small, quadrate plate with an extension directed backward and downward, half as broad and nearly as long as the centrum. Clasps consisting, on either side, of a rather small plate, rounded off posteriorly, but with the upper angle produced to a short, blunt tooth; below the middle, on the inner side, is a stout, horizontal ridge, increasing in height from base to apex of clasp, and then bearing, at its inner extremity, a long, moderately stout, slightly curving, very corneous finger.

A peculiarity in the composition of these parts in *Anosia* consists in the presence of a cylindrical sheath, directed from below upward, backward and a little outward, opening just above and outside of the upper tooth of the veritable clasps, and from which protrudes a scarcely spreading pencil of long, equal hairs (61:59), which Mr. Burgess, who has studied them from fresh specimens, finds to be attached to an introversible membrane, which can be withdrawn or extended, like the finger of a glove, or the osmateria of the caterpillars of *Papilioninae*.

Egg. About half as high again as broad, tapering rapidly and rather regularly to a roundly pointed apex, the more than twenty longitudinal ribs straight, broad, stout and bluntly rounded, nearly all reaching to or almost to the small micropyle rosette. Cross lines frequent, regularly spaced and distinct, forming quadrangular rounded meshes several times broader than high.

Caterpillar at birth. Head of the shape of the adult, smooth. Body cylindrical, not tapering at either end, the first thoracic segment as large as any. Garnished with simple hairs arising from minute papillae arranged in subdorsal anterior, supralateral anterior, lateral posterior, laterostigmatal median, substigmatal posterior and ventrostigmatal median rows, the latter two absent from the thoracic segments. On the second and third thoracic segments, moreover, the lateral posterior papillae become sublateral anterior, while on the seventh and eighth abdominal segments they become supralateral instead of lateral. On the upper half of the first thoracic segment there are five hairs on either side, three in a slightly elevated laterodorsal corneous blister, and a lateral pair close together at the side. Besides these there is on the second thoracic and eighth abdominal segments anteriorly, just below the supralateral papilla a cylindrical delicately roughened tubercle, bluntly rounded at tip, and higher than broad, the thoracic about half as high again as the abdominal.

Mature caterpillar. Head (78:16) small, pretty well rounded, but broadly, though not greatly, appressed in front and slightly compressed at the sides, the summit of each hemisphere rounded, although but little elevated; broadest and deepest next the ocelli, narrowing but slightly below the upper third, the surface nearly smooth; triangle large, nearly or quite as broad as high, reaching about half way up the head; a few irregularly and sparsely scattered, exceedingly short, fine hairs on the posterior

half of the sides, especially below. Basal joint of antennae pretty broad, mammiform, the second, a short annulus, the third cylindrical, nearly twice as long as broad, abruptly docked and bearing at the upper part of the tip a fourth, similar, but excessively small joint; the extremity also bears, at the edge, a very long and two very short and delicate bristles. Ocelli five in number, four in a rather broad curve (its convexity facing forward and slightly upward) at nearly equal distances apart, the first and second, counting from above, being more widely separated than the others, the fifth behind the fourth, so that a line drawn from the third to the fifth through the fourth would form a right angle, the distance between the fourth and fifth a little less than that between the fourth and second; fifth a little smaller than the others, which are equal. Labrum of moderate size, nearly twice as broad as long, its edges rounded, deeply excised in the middle and angulated. Mandibles pretty large but not very stout, broad, the edge straight, distinctly 4- or 5-denticulate. Maxillary palpi four-jointed, the joints successively smaller, the first two very broad and short, the third cylindrical, equal, less than twice as long as broad, abruptly docked, the fourth similar but much smaller and shorter. Spinneret tumid, pretty large, conical, four-jointed, the third joint minute, the last long and very slender, spiniform, compressed, equal viewed from above, tapering when seen from the side.

Body large, fleshy, plump, transversely wrinkled and folded, cylindrical, of nearly equal size but tapering a little forward on the thoracic segments, the first segment even slightly smaller than the head, the last abdominal segment with a broad, very low, subconical, fleshy, mediodorsal tubercle or swelling; armed on the second thoracic and eighth abdominal segments with a pair of very long and slender, fleshy, scabrous, nearly or quite cylindrical, supralateral filaments, equal beyond the base and bluntly pointed, the anterior ones slightly appressed; they increase greatly in length during development and when fully grown the anterior pair exceed the posterior several times. Segments divided very inconspicuously into a very long anterior and two short, equal, posterior sections, the anterior twice as long as the others together and with a feeble sign of a median subdivision. Whole body densely scabrous with minute granulations, occasionally interrupted by quite as minute a wart giving rise to a fine hair scarcely longer than itself: these warts are arranged in transverse rows, four or five rows to a segment, but with no great regularity. Legs short, rather slender, conical, the last joint very slender, tapering, the claw very small, tapering, a little curved; prolegs rather short, the basal joint broad, plump, the second cylindrical, broader than long, scarcely tapering, its apical outer edge with a fringe of not very frequent, rather long, curving hairs; hooklets very minute, slender, considerably curved, numerous,—from fifty to eighty—arranged in a close triple row, forming the longer half of an oval. Spiracles large, obovate, with a slender, raised, exterior rim.

Chrysalis. Body smooth, with scarcely impressed, excessively minute, short, frequent and transverse lines; largest just behind the middle of the posterior half of the third abdominal segment, where it is furnished, across the entire back, with a close row of low, blunt, smooth, slightly appressed, conical papillae; behind this the abdomen is almost hemispherical, but conically produced a little toward the cremaster; in front, it narrows considerably on the back to the hinder edge of the mesothorax; viewed from above, the chrysalis narrows a little to the middle of the first abdominal segment and then passes in a straight line to the basal wing tubercle; thorax with a broad anterior curve; viewed from above it narrows rapidly beyond the basal wing tubercle as far as the ocellar prominences, between which it is broadly rounded, almost docked; angle between the front and summit of head well rounded; ocellar tubercles conical, not very high but broad, situated just beneath the basal joint of the antennae, rounded at tip; basal wing tubercles scarcely prominent, rounded, surmounted by a small, smooth, rounded wart; a very slight longitudinally oval elevation at the upper tip of the cell of the wings; a somewhat similar but smaller and narrower elevation on either side of the mesothorax somewhat in advance of the angle made at the base of the wing; and still another slightly more elevated, subdorsal pair near the hinder extremity of the mesothorax; anterior base of the cremaster

reduced to three shallow, parallel, longitudinal grooves, and in front and outside of them a smooth, equal, rounded tubercle half as high again as broad; free portion of the cremaster long and slender, comparatively broad and appressed at base, tapering a little to a cylindrical stem, broadening again near the apex for the support of the hooklets, more than twice as long as the broadest part of the base, at base smooth, beyond deeply, rather narrowly, interruptedly and longitudinally grooved, above completely studded with a semiglobular mass of hooklets, turning in every direction; hooklets long and slender, cylindrical, scarcely at all increasing in size near the base, a little near the tip, curved very slightly throughout most of the stem, but near the tip strongly arched in the same direction, the apex bluntly rounded or sometimes bluntly conical, directed backward.

This genus, in the restricted sense in which it is here used, is, with a couple of others, confined to America, although it belongs to the *Limnæidi* or Old World group of *Euploeinae*; it is composed of not more than two or three species, possibly referable to a single one, which extends over all the warmer parts of North and South America and the intervening archipelago and is found in every part of New England. In recent times it has spread widely westward.

The butterflies, rather large in size and very striking in appearance, are tawny colored, a little paler beneath, the nervures distinctly black and the outer border of the wings broadly margined with black, and enclosing two or three rows of numerous small white spots; the apex of the fore wings is also dusky and covered with larger white and fulvous spots, some of them collected in an oblique broken patch crossing the middle of the outer half of the wing. The hind wings of the males are furnished on the upper surface with a little corneous blister or pouch-like opening, adjoining the inner side of the middle of the lower median nervule, and opening by a slit parallel to the vein but on the side away from it. It contains androconia or scales peculiar to the male sex, which, in our native species, have an odor but little distinguishable from that of the ordinary scales. Müller says that the scales at the entrance of the pocket are often wanting in flown specimens as if they had been scoured away by something introduced into the slit.

The species of *Anosia* and the allied genera are exceedingly rich in individuals, being apparently little subject to the attacks of parasitic Hymenoptera and Diptera,* so far as known almost wholly undisturbed by insectivorous birds, and very tenacious of life. They are very often the subjects of mimicry by butterflies of entirely distinct groups. Doubleday and Hewitson speak of *Tirumala limniæ* as found by Captain Cook in such numbers in Australia that he saw "a space of three or four acres covered by millions of them on the wing, and every twig and branch loaded with almost equal numbers at rest." This same insect is stated by

* Two species of chalcids have been reared from East Indian species (*Distant*, *Rhop. Mal.*, 407, note) and a *Pteromalus* and tachi-

nid fly from our native *Anosia*, and besides this the latter, as will be seen, has its egg parasite.

Mr. Hope to be used as food by the natives of Australia, but Mr. Doubleday is inclined to doubt the truth of the statement; even the most barbarous tribes would scarcely eat insects refused by birds; and they are too keen observers of nature to overlook the fact of such refusal.

These insects are polygoneutic and the winter is passed in the imago state alone. The caterpillars of this and the immediately allied genera feed wholly on Asclepiadaceae; in America *Asclepias*, *Gonolobus* and *Apocynum* seem to be selected by them; in Africa *Calatropis* is added to the list. They live in almost complete exposure and do not seem even to seek places of concealment when transforming.

The egg is high, subfusiform, tapering but slightly on the basal half and furnished with frequent longitudinal ribs. The larvae are provided with a pair of very long, slender, fleshy papillae on the second thoracic segment, and a similar but usually much shorter pair on the eighth abdominal segment;* the bodies are either greenish, transversely banded with black and colored stripes or are nearly black, with transverse series of pale dots. The chrysalids are green with a few golden spots on the thorax, and the third abdominal segment is furnished with a transverse series of raised, highly colored warts, beyond which the body tapers very rapidly.

EXCURSUS XXIII.—MIMICRY AND PROTECTIVE RESEMBLANCE; OR BUTTERFLIES IN DISGUISE.

How she sucked,
Assimilated juices, took the tint,
Mimicked the form and texture of her food!

BROWNING.—*Red Cotton Night Cap Country*.

Yet nature is made better by no mean,
But nature makes that mean.

SHAKESPEARE.—*Winter's Tale*.

EVERY observer, even the most casual, has at some time had his attention arrested by the strange resemblance of some creature to the object upon which it rested; to this form of imitation the term mimicry was applied as long ago as 1815 by Kirby and Spence in the introductory letter to their treatise on entomology.† “You would declare,” say they, “upon beholding some insects, that they had robbed the trees of their leaves to form for themselves artificial wings, so exactly do they resemble them in their form, substance, and vascular structure; some representing green leaves, and others those that are dry and withered. Nay, some-

*It will be seen, later, that the second abdominal segment may perhaps also be provided with a pair of minute filaments, at least in the earlier stages, a feature which would show the close affinity of *Anosia* to the neigh-

boring genera, which, in the mature caterpillar, are provided with well developed filaments on this segment.

† Compare Distant, *Rhop. Mal.*, p. 33, note, where a much later date is named.

times this mimicry is so exquisite, that you would mistake the whole insect for a portion of the branching spray of a tree."

It is not a little curious that it was on the very eve of the publication of the "Origin of species," at the meeting of the British Association for the Advancement of Science in 1859, that the first attempt was made to collect facts of this nature, and to inquire into the laws which regulate them. At this meeting the late Mr. Andrew Murray read a paper upon the "disguises of nature," in which he showed that the most perfect imitation of inanimate objects occurs, not rarely or exceptionally, but in some groups so commonly that the want of it might be regarded as the exception, and that the concealment of the animal was the plain purpose of the disguise. He confesses, however, that he cannot tell what law has set in motion such endless provision of protection, and can only suggest that it may be found in some force analogous to the great law of attraction; that "like draws to like, or like begets like."

The theory of natural selection, immediately afterward proposed by Darwin, was the key to this puzzle. Its use for this purpose by Bates in 1862 was one of the earliest independent contributions to the theory from new observations. Buried in the depths of a special systematic paper, Bates presented some of the most striking instances that are known of such protective resemblance, in which the animals imitate not the objects on or near which they live, nor such other creatures as are in themselves frightful or predaceous, but butterflies quite like themselves, to all external appearance as harmless and as much in need of protection as they. He pointed out, moreover, that there is a special group of butterflies (*Heliconinae*) of vivid coloring, and slow and easy flight, which are the constant subjects of mimicry, while the greater portion of the mimicking butterflies he observed belonged to a very different group (*Pierinae*), normally white and tolerably uniform in color, but which had so changed their livery and even the form of their wings as to closely resemble the objects they mimicked in brilliancy of color and variegation, and even in mode of flight. Some, says he, "show a minute and palpably intentional likeness which is perfectly staggering." Indeed, the resemblance proved so close that even after he became aware of the mimicry, his practised eye was often deceived. Or if he wandered to a new locality where occurred a new set of *Ithomyia*e (the most numerously represented among the mimicked genera), the *Leptalides* (the mimickers) would vary with them so as to preserve the mockery band for band and spot for spot.* Now his

* Mimicry has been the cause of some curious mistakes in entomology. Thus Stoll[†] figured a euploeid caterpillar, *Tithorea harmonia* (Pl. 1, fig. 5) and gave it the name of *amphione*, a butterfly belonging to the mimicking leptalid genus *Dismorphia*, and previously figured by Cramer, Stoll[†] having doubtless mistaken it for the one he raised. So, too, he

figured the larva of *Mechanitis polymnia* (Pl. 1, fig. 4) under the name of *euterpe*, an earlier known butterfly belonging to the mimicking genus *Stalactis*, one of the *Lemoniinae*, and which Hübner from the same cause classed with the *Heliconians*. Both errors were corrected by Bar (without mention of the cause) but not until they had made much confusion.

field observations showed him that the mimicking species belonged to a group very subject to attack by birds and other foes, while the group of butterflies which they mimicked had an offensive odor and apparently a taste obnoxious to insectivorous animals, so as to be practically exempt from their attacks. This was partly shown by their exceptional abundance, which did not seem to accord with slow and easy flight and conspicuous coloring, features that would naturally render them an easy prey to their enemies. That these butterflies were truly distasteful to birds has been shown over and over again. Thus Belt says :—

“I had an opportunity of proving in Brazil that some birds, if not all, reject the *Heliconii* butterflies, which are closely resembled by butterflies of other families and by moths. I observed a pair of birds that were bringing butterflies and dragonflies to their young, and although the *Heliconii* swarmed in the neighborhood and are of weak flight so as to be easily caught, the birds never brought one to their nest. I had a still better means of testing both these and other insects that are mimicked in Nicaragua. The tame, white-faced monkey I have already mentioned was extremely fond of insects, and would greedily munch up any beetle or butterfly given to him, and I used to bring him any insects that I found imitated by others to see whether they were distasteful or not. I found he would never eat the *Heliconii*. He was too polite not to take them when they were offered to him, and would sometimes smell them, but invariably rolled them up in his hand and dropped them quietly again after a few minutes. A large species of spider (*Nephila*) also used to drop them out of its web when I put them into it. Another spider that frequented flowers seemed to be fond of them and I have already mentioned a wasp that caught them to store its nest with. There could be no doubt, however, from the monkey's actions, that they were distasteful to him.” (Naturalist in Nicaragua, 316-317.)

Bates very naturally argued that if these offensive properties gave the *Ithomyia* such exemption from attack as enabled them to swarm in spite of lazy habits and brilliant coloring, then other butterflies living in the same places would gain a certain amount of freedom from attack, if their flight and coloring so nearly resembled those of the offensive species as actually to deceive insect-eating animals, even though they were themselves in no way distasteful.

The fact of a resemblance so close that it is to all appearances a “palpably intentional likeness” is impossible to question. But how explain it? How could a butterfly change its appearance to such a degree, its wings from a uniform color to a banded, streaked and spotted pattern and at the same time lengthen their form, and extend the antennae? “Can the Ethiopian change his skin or the leopard his spots?”

The answer, as Bates clearly saw, was to be looked for in the same

direction as when accounting for the assumption by animals of the color of their surroundings. Both are produced in the same way and have the same cause and end. It is only by keeping in view this tolerably obvious truth that we can explain all the freaks of mimicry. "The specific, mimetic analogies," says Bates, "are adaptations—phenomena of precisely the same nature as those in which insects . . . are assimilated in superficial appearance to the vegetable or inorganic substance on which or amongst which they live."

To gain an idea, then, of the processes by which the "staggering" examples of mimicry are produced, we must look first at the simplest forms of protective resemblance. Go to the sea-shore and observe the grasshoppers among the beach grass. They fly up at your approach, whizz off a rod or so and alight. Can you see them? They are colored so nearly like the sands they live upon that detection of one at rest is almost impossible. On yonder grassy bluff, a stone's throw away, you will find none of them, but other kinds equally or almost equally lost to sight by their harmony with *their* surroundings. What chance of life to either if they suddenly changed places? They would be so conspicuous that every passing bird or other insectivorous creature would sight them. These protective colors have of course been gained by slow steps. Every grasshopper that found its preferred food among the sands was liable to be eaten. In the long run just those would be eaten which were most easily seen; one which varied in coloring to never so small a degree so as to be less easily seen than his brother would live to perpetuate his kind, and his brother come to an untimely end; the progeny would show the fortunate variation among others and be the more probably spared to transmit in increased volume the probability of the happy coloring. Given, then, a brood of grasshoppers that find their preferred food in sandy spots, and unless other and more powerful forces act upon them, it *must* result from their liability to be eaten by creatures fond of grasshoppers that in time they will resemble in coloring the sand on which they live; it is impossible that they should not. Any creature not specially protected by nauseousness or habit or special device of some sort must in the very nature of things, if it is to live at all, have some other protection, and that afforded by color and pattern is by far the most common. The world is made up of eaters and eaten, of devices to catch and devices to avoid being caught. In his *Light of Asia*, Arnold thus makes Buddha contemplate the scene:—

. . . Then marked he, too,
How lizard fed on ant, and snake on him,
And kite on both; and how the fish-hawk robbed
The fish-tiger of that which it had seized;
The shrike chasing the bulbul, which did hunt
The jewelled butterflies; till everywhere

Each slew a slayer and in turn was slain,
Life living upon death. So the fair show
Veiled one vast, savage, grim conspiracy
Of mutual murder, from the worm to man,
Who himself kills his fellow.

We may apply the same reasoning to two kinds of butterflies subject naturally to the same class of enemies, i. e., living in the same region and flying at the same time. If one has the slightest advantage over the other in the fight for life, by being for instance distasteful to one class of common enemies, so that these forbear to attack him after experiment or by instinct (the result of ancestral experiments); and there be among the less favored flock, here and there, an individual which under circumstances favoring it, such as distance or shadow, may more often than its fellows be mistaken by the enemy for one of its distasteful neighbors through its possession of a little more than usual of a certain tint on a part of the wing, a little larger spot here, or more of the semblance of a band there,—how small soever this difference may be, it must, by the very laws of natural selection, be cherished, perpetuated, increased by slow but sure steps. Nor is there any limit to its increase, except its absolute deception of the enemy. So long as there is the slightest advantage in variation in a definite possible direction, the struggle for existence will compel that variation. Knowing what we now know of the laws of life, mimicry of favored races might even have been predicted.

It is to be presumed that the actual colors found in a mimicking butterfly are, with rare exceptions, such as existed somewhere in the ancestral form. In the case of our own mimicking *Basilarchia*, for example, whose orange ground tint is so totally at variance with the general color of the other normal members of the group, it will be observed that all the normal species possess some orange. Without this as a precedent fact, such perfect mimicry might perhaps never have arisen. Individuals among the normal species vary somewhat in this particular, so that it is easy to suppose that some of the original archippus with more orange than usual may have escaped capture on occasion from this cause. From such a small beginning, such as one may now see every year in *B. astyanax*, sprang doubtless the whole story, and we now find a butterfly which has for a ground color of both surfaces of the wings an orange which is the exact counterpart of that of *Anosia plexippus*; by reason of which in all probability it enjoys a freedom from molestation comparable to that attributed to *plexippus*, so that it ventures more into the open country than its allies, and thus gains a wider pasturage and surer subsistence.

It would seem then to be plain that all cases of protective coloring and mimetic form come under one and the same law and have been produced

by the same means (the survival of the best mocker), whether the object imitated be animal, vegetable or mineral; the actual outcome is indeed vastly more surprising in some cases than in others; in some "perfectly staggering" as Bates says, but though there be to all appearances a "palpably intentional likeness," there is found to be no intention in the case so far as mocker and mocked are concerned; but the result of a natural selection against which neither could even strive, and of which neither was ever conscious.* The process has been a long one, so that in the case of parastatic mimicry, as that form which involves the copying of one's fellows might be termed (or if one prefers an English term—neighborly mimicry), we may readily presume far less difference between mocker and mocked when the mimicry between them first began, than now exists between the mocked and the normal relatives of the mocker. It is argued, indeed, with great show of reason, that as the resemblance grew stronger the birds became more sharp-sighted, which reflected again on the mimicry, and that thus the final departure from the normal type was intensified; but this assumption is not necessary.

So far we have only referred to the first illustrations of mimicry given by Bates, presenting the simplest forms though not the least striking, involving as they do the widest departure of mimetic butterflies from their normal type. Let us glance briefly at some other points.

A new element enters when we find that neighborly mimicry is sometimes confined to a single sex of a butterfly; that is to say, one sex is of the normal color of its allies, while the opposite sex departs widely therefrom, and is found to resemble closely another and a nauseous butterfly of the same region. Now, as mimicry is clearly only a protective device, or rather outcome, we should naturally inquire whether either sex was more in need of protection than the other from those foes against which mimicry could avail anything. Plainly, it would be the female, since were she lost before oviposition just so many eggs are lost with her; and besides this her heavier, more sluggish flight—a necessity from her burden of eggs—makes her an easier prey to insectivorous creatures, against which mimicry is aimed. Accordingly we find numerous instances in which the female is mimetic and the male normal. Probably they are far more numerous than we imagine and that many of the exceedingly common differences between the sexes which since Darwin's day we have been wont to set down to sexual selection are to be attributed to something of this nature. But there is no known case of neighborly mimicry confined to the male sex. On the other hand some of the most vivid and striking examples of mimicry are to be found confined to the females. There is one example brought forward by Trimen which is the most surprising yet

* "Imitation" and "mimicry" both imply intention; but the limits of our language compel us to use figurative speech; we have no word to express unconscious mimicry.

published, where not only have two kinds of African swallow-tail butterflies, one with, the other without, tails, long supposed to be widely distinct species, been now proved to be male and female, the female departing from the type to mimic a Euploeid butterfly; but the male is found to have no less than three distinct wives, each mimicking a different kind of Euploeid characteristic of the region inhabited by mocker and mocked, and each very different from the husband; while an allied male, formerly thought to be the same as the preceding, keeps a similar harem, similarly mimetic of species of Euploeinae prevailing in its districts, and, besides, has in one place at least a concubine which is not at all mimetic. Surely the play of mimicry can go little further.

But in all this arises a new difficulty. How is it that mimetic qualities, which in a given locality breed so true, are inherited by one sex only? Why do the males escape? Here the question is, not, why are the females mimetic? but rather, why are the males not mimetic? To this no satisfactory answer has yet been given. It has been attributed to sexual selection, the females being supposed to be of a conservative frame of mind, and admitting no variation in their consorts; but this it would be difficult to prove, or, it seems to me, to render very probable.

This, however, is the view of it taken by Belt, who remarks that "it is supported by the fact that many of the males of the mimetic *Leptalides* have the upper half of the lower wing of a pure white, whilst all the rest of the wings is barred and spotted with black, red or yellow, like the species they mimic. The females have not this white patch, and the males usually conceal it by covering it with the upper wing, so that I cannot imagine its being of any other use to them than as an attraction in courtship, when they exhibit it to the females, and thus gratify their deep-seated preference for the normal color of the order [tribe] to which the *Leptalides* belong." (*Naturalist in Nicaragua*, 385.)

Still another difficulty besets the subject,—a difficulty in part recognized by Bates. It has been the subject of much discussion, but on the principles supported above is far more easily disposed of. Bates found not only that the distasteful *Heliconoid* butterflies were mimicked by those which were in evident need of protection, from the fact of their being greedily eaten by insectivorous animals, but that there were cases of mimicry quite as close among the *Heliconoid* butterflies themselves. Numerous instances of the same kind have since been recognized in other parts of the world. Here both mocked and mockers were protected by nauseousness, and it was by no means clear to him how any advantage, the fundamental cause of variation of this kind, was to be gained by such imitation. The resemblance was so close that, according to his own words, "species belonging to distinct genera have been confounded, owing to their being almost identical in colors and markings; in fact, many of them can scarcely be dis-

tinguished except by their generic characters." Bates himself was inclined to look upon these not as cases of parastatic mimicry, but as due "to the similar adaptation of all to the same local, probably inorganic conditions."

But this vague explanation has not been satisfactory to others, and Wallace and Meldola, and particularly Fritz Müller, have followed up the matter and shown that, if the mimicked species possessed the slightest advantage in the mere point of numbers, over the mimicking, this advantage is sufficient to produce the mimicry concerned. It is highly probable, from the experiments of Fritz Müller and the observations of Belt, that the *Heliconoid* butterflies are simply distasteful, not poisonous, to insectivorous animals. Müller has even figured a considerable number of examples of a single species found by him (in this instance belonging to the *Acracinae*, a closely allied nauseous group) in which the wings had evidently been seized by insectivorous birds, having great gaps in their wings, such as a bill would make upon them. By such seizures many of the distasteful butterflies doubtless perish, and Meldola shows very clearly by mathematical analysis that a resemblance between two species so close that the experimental seizures would be divided between them in the ratio of their numbers, gives an advantage decidedly in favor of the scarcer species. Or, as Wallace puts it, "if two species, both equally distasteful, closely resemble each other, then the number of individuals sacrificed is divided between them in the proportion of the squares of their respective numbers." If the rarer species is only one-tenth as numerous, it will benefit in the proportion of one hundred to one.

Exactly the same argument can be applied to mimicry between two species neither of which is distasteful, which though less conspicuous are probably more numerous than the other class; for on the principles that we have laid down, any advantage which one species has over another will be attacked by that other in every possible way; and if there be elements in the structure or markings which admit of a closer resemblance between the two, and this resemblance will lessen the disadvantage under which the weaker species labors, then in the very nature of things that resemblance must follow, unless other opposing elements intervene. For here at least the relative abundance of the species concerned is an essential element. It has been thought by some that it was also an essential element of all mimicry, but not only is there no sufficient reason for holding such a view, excepting in cases like those last quoted, but it has been asserted by no less keen an observer than Fritz Müller himself, and agreed to by others, that the mimicked species is not always more abundant than its counterfeit; indeed, the mimicking and the mimicked species have been found to vary in their relative numbers in different localities, sometimes the one, sometimes the other preponderating. But with regard to mimicry of one distasteful but-

terfly by another, there may also enter another element ; for it is hardly to be believed that all distasteful butterflies are equally distasteful to all birds, and it is obvious that the more distasteful the butterfly is to its rapacious foes, by so much more has it the advantage in the struggle for life, so that mimicry of one distasteful butterfly by another less distasteful is scarcely more surprising than the mimicry of a nauseous butterfly by one that has not this quality.

Only one further difficulty remains, and this is that, in a few instances, an insect has been found differing so peculiarly from its congeners as to leave no doubt in the mind that it differs in the direction of mimicry when no exact prototype can be found. For example, the butterfly of one of the *Nymphalinae*, with normal dark colors and a definite pattern, will vary altogether from that pattern and coloring, to take on the livery peculiar to the *Euploeinae*, a group very extensively imitated, when there is found in the regions inhabited by this supposed mimicking species no *Euploid* which it in any way specially resembles. In this case but two explanations have been offered, one that the mimicked butterfly has not yet been found, another that it has for some cause become extinct. But with the extinction of the mimicked form we should expect speedy extinction of the mimicking, and it would seem more probable that these were cases of general mimicry in process of formation toward some specific type. At any rate we need to know more definitely about these instances before we can properly discuss them. They have never been collated.

In support of the general theory of mimicry, it may be said that cases are far more common in the tropics than in temperate regions, even relatively ; and so, too, are insectivorous animals. The accounts of travellers in the tropics constantly mention the attacks of birds upon butterflies, while instances of butterflies being seen pursued by birds are vastly more rare in the temperate regions. I have never seen one. In the tropics, moreover, they are aided by a greater number of other insectivorous animals, such as lizards. In our own country, therefore, we should not look for many instances of mimicry of any decided type. The most striking is unquestionably that of *Basilarchia archippus*, which mimics *Anosia plexippus*, and the closely related case of *Basilarchia eros* and *Tasitia berenice*, the last two butterflies largely supplanting the first two on the peninsula of Florida. In both these instances the mimicry is enjoyed by both sexes. A third case is found in the less close but still striking mimicry of *Basilarchia astyanax* by the female of *Semnopsyche diana*, an instance the more remarkable as the mimicked species belongs to the same genus as our two other mimicking forms.

When we take a general view of mimicry as exhibited by one butterfly for another, how strange it seems, and what an interesting illustration it is of the adaptability and pliancy of natural forces, that for the evident pro-

tection of one species in the struggle for existence, so exact and beautiful a resemblance should be brought about! Consider for a moment that the subjects of mimicry are at the final stage of life; they have already passed through nearly all the dangers to which the species as a species is subjected; so rudely subjected that they are indeed but a centesimal or even less, rarely or never more, of those brought into the world with them. During the early period of their life they were exposed to vastly more dangers than they can now experience. At times they were absolutely helpless, without the power of movement. They are now endowed with powers of flight sufficient to thwart the purpose of many a foe, yet it is in just this period that these special and extraordinary provisions for their safety and for the accomplishment, as far as the species is concerned, of the end of their life, are given them. All this has been brought about for the sole purpose of prolonging their aerial life for the exceedingly few days which are necessary for pairing and the deposition of eggs. The more we contemplate so strange and so perfect a provision, and the means by which it is accomplished, the more are we impressed with the capabilities of natural selection, and begin to comprehend how powerful an element it has been in the development of the varied world of beauty about us.

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ANOSIA PLEXIPPUS.—The monarch.

[The monarch (Scudder); the Archippus (Gosse); the Archippus butterfly (Harris); the storm fritillary (D'Urban); web-footed danay (Emmons); Queen of Spain butterfly (Ross); milk-weed butterfly (Burgess); Bermuda butterfly (Jones); the storm king (Moffat); the storm butterfly (Grote).]

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Figured by Glover, Ill. N. A. Lep. pl. 1, fig. 2, ined. See also Emert., Proc. Bost. soc. nat. hist., xxiii: 437-460, pl. 3 (1888).

[Not *Papilio plexippus* Fabr. (Ent. syst.); nor *Danaïs plexippus* auct. mult.; nor *Danaïda plexippus* Auriv.]

—Lazily flying
Over the flower-decked prairies, West;
Basking in sunshine till daylight is dying,
And resting all night on *Asclepias*' breast;
Joyously dancing,
Merrily prancing,
Chasing his lady-love high in the air,
Fluttering gaily,
Frolicking daily,
Free from anxiety, sorrow and care!

C. V. RILEY.

Imago (1: 7; 16: 10). Head velvety black; at nearly equal distances in front of and behind each antenna a creamy white spot, that in front the larger and roundish, that behind triangular; between the bases of the antennae a few white scales arranged in a very small triangular spot; and on the outer hinder border of the basal joint of the antennae a white dot; behind the middle of the eye and bordering the same a small patch of similarly colored scales. Antennae uniform blackish brown; palpi black, some of the scaly hairs protruding from the front very dark yellowish brown at base, the middle of the outside of the basal joint with a very large roundish white spot; middle joint with a similar, larger, triangular streak; inner upper side of protruded tip with two very small, inconspicuous, nearly confluent, longitudinally disposed white spots, which do not reach the borders. Tongue piceous.

Thorax above velvety black, with a white mediodorsal line over most of the meso- and metathorax and the latter covered with exceedingly long and delicate mouse brown hairs; prothorax with a pair of large, compact, round, white spots, tinted with yellow, and separated by twice their own diameter; patagia with a similar but still larger central white spot, the tip and apical edges narrowly bordered with the same; beneath the thorax is black, ornamented with a pretty large, round, white spot just in advance of the costal border of fore wings, a similar one at the base of each wing, besides about fifteen larger and smaller ones on either side, irregularly disposed. Legs blackish purple, the hind coxae with an anterior outer white spot, the anterior femora marked conspicuously with a broad white streak on the outer side away from the base, occupying almost the entire apical half; anterior tibiae edged beneath outwardly with white, most conspicuous at either extremity. Claws, spurs and spines black.

Wings above rather light tawny brown, the veins narrowly (♂) or broadly (♀) margined with black, having a faint purplish reflection. On the *fore wings*, the tawny brown is found in a very large patch, crossed by black veins and which includes the cell, the basal three-fifths of the upper median interspace, the basal three-fourths of the

lower median interspace, and all of the medio-submedian interspace excepting the broad, black border; beyond, all is black, spotted and streaked with white and tawny; the whole costal border as far as the subcostal nervure is black, with five white dashes in the basal three-fourths of the wing: two just above the tip of the cell, the under usually the longer, divided by the first subcostal nervure: a similar pair, sometimes united, beyond, at a little less distance than the greatest width of the cell; and a single dash at an equal distance toward the base. Outer margin with a wide border of black, nearly or quite as broad as an interspace: a row of fourteen or less small, submarginal, whitish spots, two to each interspace above the submedian nervure, the upper roundish, the lower usually oval and diagonally disposed: this row is followed interiorly by a series of eleven or twelve larger, unequal, roundish spots, the uppermost usually white, the others of a buff, tawny color, approaching the submarginal row below and confluent with it at the lowest spot, above curving abruptly inward; a large, triangular, black patch, just beyond the cell, bordered below by the upper branch of the median, unites the black edging of the costal and outer borders and contains five large spots, usually of a buff, tawny color, the upper ones often more or less white; two of them are oblong, ovoid patches, one above the other, forming a row just beyond the extremity of the cell, in continuation of the two middle spots on the costal border; two others are situated one above the other, separated only by a nervure, just beyond the outer pair of costal spots; together they form a large, quadrate, transverse patch; the fifth is as large as the last two together, roundish or subquadrate, situated beyond the middle of the subcosto-median interspace; beyond this triangular patch each of the three larger subcostal interspaces has an oblong tawny patch, much obscured by black scales, especially along the edges, which are consequently ill-defined; whole of the inner border, below the submedian nervure, black, excepting a slender, longitudinal patch next the base: fringe white, interrupted with blackish brown, broadly at the nervure tips, narrowly at the middle of the interspaces. *Hind wings* with a black border as broad as the width of an interspace, extending from the anal angle, nearly as far as the first divarication of the subcostal nervure; this is enlivened by two rows of roundish white spots, sometimes tinged with tawny, equidistant from each other and from each border, two in each row in each principal interspace, the middle ones small, sometimes obsolete, those at either extremity larger; especially is this the case with those of the upper row next the anal angle, and still more with those situated on the costal border, where the two rows are confluent and end in a large, ill-defined, quadrate spot at the very extremity of the black bordering; the inner margin is narrowly edged with black and on the anal area the brighter colors are usually paled. The male is provided with a small, raised, oval, black patch on the inner side of the first median nervure, midway between its origin and the black border; fringe as on the fore wings.

Beneath: *fore wings* of the same color as on the upper surface, with the same and a few additional markings; the black median nervure is, however, bordered in the tawny field by reddish tawny instead of black; the inner border is of a soft drab brown, the white spots of the outer margin greatly enlarged and conspicuous, the colored patch in the principal subcostal interspaces much more conspicuous, occupying almost the whole of the interspaces not obscured by black scales and of a tawny buff color divided by the black nervules; the larger spots of the black, triangular patch scarcely differ from the same on the upper surface but besides having the white dashes of the costal border of the upper surface enlarged there are additional ones, the single one nearest the base being accompanied beneath by another very long one, and there are one or two long streaks toward the apex of the wing; next the base, too, the costal border is streaked by an extended dash of creamy white, somewhat obscured by blackish scales, not reaching the base nor the first white spot, and leaving the costal edge black; there is also a pretty large, whitish, triangular or quadrate patch in the extreme upper outer angle of the discoidal cell, and at the upper base of the subcostal nervure a minute, white spot; the fringe as on the upper surface. *Hind wings* of a nearly uniform buff color, a little deeper next the outer margin, all the veins

broadly bordered with black and this edged narrowly and inconspicuously with white scales; border as on the upper surface, excepting that the white spots are all large, round and conspicuous as on the under surface of the fore wings; there is also a white spot at the extreme upper base of the subcostal nervure and another smaller one between the base of the median and submedian nervures; the fringe as upon the upper surface.

Abdomen rich dark purplish brown, the last five or six segments with a slight posterior edging of white scales on the sides above; beneath a broken powdery medio-ventral line of buff white on the basal half, and beyond three or four median patches of buff white; sides with a slender continuous line of buff white and the last three or four segments with some additional paler fleckings, on the posterior edges of the segments. Appendages of male (33: 23, 24); upper organ with the hook directed downward more than backward, nearly as long as the centrum, equal, half as long again as broad and broadly rounded at the tip. Clasps with the posterior border at about a right angle with the inferior, but with the angle rounded off*; the upper tooth is triangular, about as long as broad, pointed†; the finger of the interior ridge is directed backward and a very little downward‡, and is nearly equal, a little compressed, slightly twisted, rounded at the tip, bent toward that of the opposite clasp, but close to the tip turned slightly in a reverse direction; its apical half is transversely wrinkled§. The males also possess an extensile pencil of hairs (61: 49, 59) on each side of the last abdominal segment, which spread when the pencil is fully extended; each hair is straight, simple, gently clubbed at the tip and .02 mm. in diameter.

Measurements in millimetres. Length of tongue, 16.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest	Smallest.	Average.	Largest.
Length of fore wing.....	50.	52.	57.	51.	54.	55.
antennae.....	17.5	18.	19.75	17.75	18.5	19.
hind tibiae and tarsi.....	12.	12.5	13.5	12.5	13.1	13.25
fore tibiae and tarsi.....	4.5	4.65	5.4	6.	6.25	6.25

Length of claws (not included in the leg measurements above), 2 mm.; of blister on hind wings of male, 2.6 mm.

Aberrations and variations. A. P. FUMOSUS (*Dan. archippus* var. *fumosus* Hulst, Ent. am., ii: 182, 1886) "Differs from the type form in having the whole of the surface of the wings which ordinarily is bright fulvous, of a deep, sooty brown color." This form is also referred to as exhibited at meetings of the Brooklyn entomological society (Ent. am., i: 140, 159, 180).

Butler describes the Jamaican form, also occurring in Venezuela, with immaculate black border to hind wings as a distinct species. According to Godman and Salvin, the form prevalent in the northern part of South America is one in which the spots in the apical portion of the fore wings are purer white than in North American examples. Jenner Weir writes me that all the specimens taken in England which he has seen have the five large subapical spots of the fore wing, i. e., those found at a little less than midway between the tip of the cell and the tip of the wing, tawny, and this

* In southern specimens — Lagoa Santa, Venezuela, Guatemala, Hayti—it is at more than a right angle and the clasp is much narrower at the tip than in the New England specimens.

† In southern specimens, as above, it is about twice as long as broad.

‡ In southern specimens, considerably downward.

§ In specimens from Lagoa Santa the apex is obscurely bifid.

Specimens from Hayti and Venezuela—in which also the cell of the hind wing approaches

the hinder margin more closely than usual—have the posterior edge of the clasp-like eighth abdominal segment less considerably excised, and the upper angle less produced to an appendage, than obtains in New England specimens. This is, however, not true of a specimen from Lagoa Santa in Brazil where the cell is even longer, nor in Guatemalan specimens where the cell is similar to that of the New England butterflies. The Guatemalan insects, in these two particulars, thus resemble New England types rather than those of warmer regions.

is the case also with all he has seen from the West Indies, Fiji and Australia; which renders it the more probable that all these places were colonized from North and not from South America. It may be added that in the South American type, the spots next the apex of the cell of the fore wings are sometimes absent. See the notes on the preceding page for some other distinctive features of more importance.

Accessory sexual peculiarities. The pouch on the hind wings, alluded to under the genus, is one of the notable sexual characteristics of the male. It is long oval in form, deflecting the vein in the immediate proximity (38: 2; 44: 2) and a cross-section (44: 3) shows that it is only about double the size of the vein. It opens away from the nervule. At its mouth the scales are alternately broad, rounded or quadrate-oval (46: 5, 6) and fan-shaped, trilobed at tip (46: 7), the middle lobe broader and more rounded than the others, as pointed out by Fritz Müller. On the nervule near by are many slender, round-tipped scales (46: 8); while the floor of the pouch itself is occupied by somewhat symmetrically and pretty evenly distributed blackish scales, paler at the base, which appear to be the androconia proper and are of two types: one laminate (46: 9), long oval, generally roundly and angularly subtruncate at tip; the other rod-like (46: 10), more or less, but very faintly and gradually, incrassated apically and expanded slightly at the base, where, according to Müller, they are seated in the centre of a chitinous annulus, wanting at the base of the other scales. Besides this there is the extensile pencil of clubbed hairs at the tip of the abdomen, described above.

Egg (64: 1). Very pale amber green, becoming grayish before hatching. Vertical ribs twenty-two in number about .1 mm. apart in the middle, the intervals smooth and glistening, broken by bands .012 mm. in width, giving the egg somewhat the appearance of being overlaid with a thick layer, perforated by regular meshes which are the cells between them; in the largest part of the egg these cells are about .08 mm. in breadth and .025 mm. in height, being quadrangular with rounded sides. Summit of the egg about .1 mm. in diameter (67: 4), not at all sunken but gently convex, the outside cells about .01 mm. in length, and the micropyle proper .05 mm. in diameter. Height of egg usually about 1.2 mm. and the breadth .85 mm.

Caterpillar. First stage (70: 3). Head (78: 1) piceous, with scattered, delicate and short black hairs; labrum and labium very pale green; other mouth parts fuscous; antennae pale. Body pale green, narrowly banded on the anterior end of each abdominal segment with pale olive green slightly infuscated. Last segment black posteriorly. Skin shagreened by a fine punctuation. Hairs very slender, scarcely tapering, bluntly tipped, not clubbed, about half as long as the segments, black. Tubercles on second thoracic and eighth abdominal segments brownish fuscous, scarcely appressed at base; laterodorsal blister of first thoracic segment piceous. Legs and prolegs beyond basal joint black, the latter only outwardly, and ringed with green apically. Spiracles showing a black ring on a pale ground. Length, 3 mm., breadth, .45 mm. The colors grow darker with age.

Second stage. Head (78: 2) black, the centre of the triangle white; parallel to the hinder border are two broad, equidistant, whitish bands broken in the middle above; hairs black. Body lemon yellow, each segment with a central, transverse, white band, containing a central, transverse, purplish black stripe, running with equal width around the body, on the pedigerous segments passing down the front of the prolegs; the last abdominal segment wants the white band but not the black and is tipped with black; the first thoracic segment is almost entirely white, but has a transverse dusky stripe, in which, on either side, is a large, laterodorsal, transversely oval, shining black spot. The fleshy threads are short, thick, bluntly pointed, black, the front ones a little appressed; the black hairs are arranged in transverse rows, one in the middle of each bright stripe, and they are not infrequent. Spiracles black, annulate with luteous; legs black; prolegs whitish, black tipped. Length, 7.25 mm.; breadth of body, 2 mm.; length of anterior filaments, .6 mm.; of posterior pair, .25 mm.

One of these caterpillars, preserved in alcohol at its second stage, showed on examination a couple of little threads upon one side; on attempting to raise them, they came off with the instrument, leaving, however, no mark of attachment on the body,

but they may have been a third pair of filaments belonging to the second abdominal segment. They were .65 mm. long and .02 mm. in diameter, exceedingly slender, rather short, equal, apparently smooth, excepting at the tip, where they appeared to be knobbed, and at the base, where they showed signs of having been torn from some object. It is a point of some interest, since flexible filaments are found on this segment in the full grown larva of *Euploea* and also in that of the neighboring genus *Tasitia*, of which we have a common species, *T. berenice*, in the south. Unfortunately I have forgotten to verify the point when I have since had the opportunity of seeing the caterpillars alive.

Third stage (78: 3). The anterior filaments have become 1.5 mm. long, are wholly black, nearly cylindrical, scarcely tapering at all, broad at tip and bluntly pointed, measuring here .2 mm. in diameter, throughout rough with minute but coarse curved serrations pointing toward the apex and divided by circlets of short spines .05 mm. long, into apparent joints, averaging .8 mm. in length; the hinder pair, which are .8 mm. long, are similarly formed; on the first abdominal segment is a pair of latero-dorsal black spots.

Fourth stage. Head (78: 4) as before. Body bright yellow; on each segment a very broad, central, whitish, transverse band, extending over the whole dorsal and lateral region, edged on either side with blackish fuscous; in the middle of each of these a distinct, transverse, purplish black line, which passes through the posterior two-thirds of the spiracles, and reaches the anterior base of the prolegs, on the segments where they occur; the last abdominal segment is tipped apically with black, and is nearly destitute of a whitish band; anterior filaments blackish purple, paler posteriorly, directed upward, forward and outward, and curved a little forward; posterior pair similarly directed, but backward instead of forward, and straight; spiracles black, broadly annulated with blackish fuscous; prolegs white at base, black posteriorly and apically. Length, 24 mm.; breadth of body, 5 mm.; length of anterior filaments, 6 mm.; length of posterior filaments, 2.25 mm.

Last stage (74: 5). Head (78: 5; 86: 37), lemon or greenish yellow, broadly and conspicuously banded with shining black; following either side of the suture of the triangle and the division between it and the labrum, is a broad black Δ , the sides a very little bowed; the head is broadly bordered behind with black, and midway between this border and the deltoid spot, is another band, equally broad, passing down each side of the head and terminating just behind the antennae; the yellowish parts of the head are faintly spotted with pellucid, the spots made up of aggregated pale dots; hairs blackish; basal joint of antennae white, encircled at base with black; other joints black, the last tipped with white. Ocelli black, all but the posterior one seated in the middle black band. Labrum yellowish; mandibles black; maxillary palpi yellowish, the tips of the joints annulated with black.

Each segment of the body is bordered both anteriorly and posteriorly with lemon yellow, forming at the junction of two segments a broad, transverse band, sometimes obscured in the middle by a line of blackish fuscous on the posterior edge of the first of the two segments; this band is bordered with black, in front narrowly, behind, also narrowly on the thoracic, but broadly on the abdominal segments. The band formed by the latter bordering, that is the black band on the anterior portion of the segment, is wanting on the sides of the thoracic segments, and forked on the first to the seventh abdominal segments; the anterior branch of the fork is nearly continuous with, but a little anterior to, the main band—parted from it on the first and second abdominal segments—broadening beneath into a blackish fuscous, broad belt, and passing just behind the prolegs on the segments bearing them; the posterior branch is short, attenuated, and directed toward the anterior base of the succeeding proleg, terminating at the stigmatal line. The remainder of the segment is white, traversed across the middle by a broad, equal, transverse, black band, which passes down the anterior edge of the legs and prolegs on the segments which bear them, including the spiracles in its posterior half, as well as the fleshy filaments. The posterior edging of the second thoracic segment is broadened on the dorsum. The last abdominal segment is wholly yellow

with a central, broad, black stripe, and is tipped posteriorly with blackish fuscous, surmounted with black. Filaments cylindrical, a little appressed, especially at the base, black but not purplish. Spiracles shining piceous. Legs black covered with a few short, black hairs: prolegs black above, shining black below, the ventral pairs white externally. Length, 45 mm.; breadth of body, 7.5 mm.; breadth of head, 3.75 mm.; length of anterior filaments, 12-14.5 mm.; length of posterior filaments, 4.5-8 mm.; length of hairs on body, .05 mm.

Chrysalis (83: 1-3). Uniform delicate pea green, somewhat beclouded by a pale, silvery gleam; the abdominal segments frequently bordered with yellow, and their dorsal surface, posterior to the transverse row of warts, with not infrequent fuscous specks, inconspicuous even with a lens. Tips of ocellar tubercles, and the centre of the first joint of the forelegs, basal wing tubercles, the two pair of tubercles on the mesothorax and the raised blister-like surface at the extremity of the cell of the wings, gilt. At the anterior outer edges of the first abdominal segment is a small wart, having a black speck at tip. The transverse row of tubercles on the third abdominal segment is situated in a tri-colored band, anteriorly shining piceous, centrally nacreous and posteriorly gilt, the division line of black and nacreous crossing the middle of the tubercles; terminal abdominal segment with a rather large, transverse, shining piceous, dorsal spot and a pair of small, piceous, subventral spots, placed anteriorly and each with a hemispherical wart; connecting each of them with the sides of the cremaster is a broad, curving, shining piceous streak. Cremaster shining piceous. Spiracles of the color of the body with very pale testaceous lips. Length, 27.5 mm.; length of cremaster, 3 mm.; breadth of body at abdomen, 11.5 mm.; at hind border of metathorax, 9.75 mm.; at basal wing tubercle, 10.25 mm.; at ocellar tubercles, 3.5 mm.; height of abdomen, 11.75 mm.; of thorax, 9.75 mm.

The proper name of the butterfly. By the almost universal agreement of those who have recently given the subject special study, this insect should bear the specific name of *plexippus*. The only dissenting voice is that of Aurivillius. I believe I was first to call special attention to the proper specific name in my "List of the butterflies of North America," published by the Buffalo society of natural sciences in 1878 (Bull., ii: 245). This was followed directly by Strecker in 1878 in his Catalogue, in which he adopted exactly the separations that I had made. More recently Godman and Salvin in their "Biologia Centrali Americana" came to the same conclusion, referring approvingly to Strecker's distinctions. And in the recent monograph of the group by Moore, the same conclusion is adopted, which in brief is this: that the species was first described under the name of *plexippus* by Linné in the tenth edition of his "Systema Naturae." The description was applied only to the North American species; that Linné afterward in his *Museum Ludovicae Ulricae* confounded with the American species one from Asia; and the two specimens now remaining in the original collection are stated by Aurivillius to belong only to the Asiatic species. Aurivillius comes to the conclusion that the name of Linné should be reserved for the Asiatic species; but as he himself agrees with all others that the original description referred to the American species and to the American species only, there can be no reasonable doubt that the name *plexippus* should be retained for it. Moreover Linné refers in the original to the figures by Catesby and Sloane, the first of which refers to

the present species, the second to a closely allied form from Jamaica, possibly only a variety and not a distinct form. The confusion in the names was brought about, however, mainly by Fabricius, who first distinctly misapplied the name of *plexippus* to the Asiatic species alone and redescribed the American form under the name of *archippus*. As there can be in this case no doubt whatever that the species was first described by Linné under the name *plexippus*, and as at the time he did not confound it with any other form, there can be but one conclusion; which is that the species should bear the specific name of *plexippus*.

- **Natural distribution.** This magnificent butterfly is more widely distributed than any of our species, if we except those which also occur in Europe and have perhaps been introduced thence. If the insect from Brazil described by Cramer under the name of *erippus* is really identical with our New England species, then it ranges over the whole North American continent from Atlantic to Pacific, as far north as the annual isotherm of 40*, and over that portion of South America laying east of the Andes and north of Rio, including also many and perhaps all of the West India Islands as well as Bermuda. There are specimens in the British Museum and the Museum of Comparative Zoology, from Cuba, St. Domingo, and St. Thomas and from Canto Gallo, Pernambuco, Lagoa Santa, Corcovado and Para, South America, and it has recently been recorded by Berg from Patagonia which it probably has reached by way of the slopes of the Andes, though it is unknown in Chili. The probable natural limit of its northern distribution is not far south of the boundary line dividing the Canadian and Alleghanian faunas; at least so far as eastern America is concerned. By natural limits I mean the limits within which the insect is to be found undergoing its natural transformations year after year without annual extinction during the cold winter. This boundary in the east may be said to be probably not far from the northern parts of Connecticut and Pennsylvania or about the northern limit of the Alleghanian fauna, though it doubtless extends further north along the river valleys of southerly flowing streams, and may be annually extinguished in the higher and colder regions further south, such as the Catskills, and even the Alleghanies. In the interior it probably extends further north than near the coast.

- **Annual excursions.** For, a review of all the facts of its occurrence in the north leads me to believe, what indeed was first suggested many years ago by Riley, that in the northern districts of its range this species will annually perish during the colder season, when the butterfly hibernates, and be replenished by excursions northward from the borders of its natural territory, so as in the latter part of the season to be found very

* This general statement does not here necessarily include the whole of the Rocky Mountain district though it is meant to cover the greater part of it.

abundant. Indeed it is not improbable that it is as regular a migrant as the birds, returning southward in the autumn. The principle, and, so far as I can see, the only serious objection to this belief is the fact that it is found in such numbers so very far north and has been known to occur, in single instances at least, to an immense distance toward the arctic regions. It has not only been found in every nook and corner of New England, but far beyond that; it is known from Nova Scotia (Jones), Quebec, not common (Bowles) and Ottawa, Can. (Billings), Moose Factory, Hudson Bay (Wier), the northern shore of Lake Superior (Agassiz), the Red River valley (Dawson), the Saskatchewan country (American entomologist, iii: 102) the north-west territories of Canada (Geddes), and even as far north as the Athabasca country (Geffcken). That the insect might cover New England every summer would be easily believed. But the extreme distance of Moose Factory and the western shore of Hudson Bay from its supposed natural limits renders confidence in these boundaries somewhat less secure. Still the facts which we shall give concerning its annual history in New England, together with those concerning its wide exotic extension in recent times will render it more plausible. Few reports have been returned of its occurrence in the Rocky Mountain region, excepting from Colorado where, according to Mead, it occurs everywhere below the timber line; but it has also been recorded from western Wyoming, Utah and Arizona. It is, moreover, common along the entire Pacific shore as far north as Vancouver Island, was found by Captain Geddes at all points in the "northwest territory," but is rare in British Columbia (Fletcher). It is probable, therefore, that it occupies, at least at times, all the less elevated portions of the region colored on the map.

That there is a regular annual southward movement of butterflies, as intimated above, is certainly not proven, but the numerous cases in which a southward migration has been observed at the close of the season over considerable tracts of territory in different years, tends strongly to the belief that this is the case. Riley was also the first to suggest such a return movement. In a paper read before the Academy of sciences of St. Louis, the substance of which was published in its Proceedings (iii: 273-274) and in the Scientific American for April 6, 1878 (see also American entomologist, iii: 100-102), he remarks "there is a southward migration late in the growing season in congregated masses and a northward dispersion early in the season through isolated individuals." As regards the southward movement in the autumn, he remarks in his paper in the St. Louis Academy's Proceedings, "the newspapers in the southwest and the signal officers were constantly reporting the passage from Iowa, Kansas, Missouri and Texas of swarms of the butterflies during the months of September and October last." These consisted, in every case where determined, of *Anosia plexippus*. A few cases may be cited.

In his third Missouri report Riley states that P. B. Sibley of St. Joseph, Missouri, on September 19, 1868 saw "millions of them filling the air to a height of three or four hundred feet for several hours, flying from north to south." Also large flocks, according to Thomas Wells, passed over Manhattan, Kansas, in a southerly direction in the evening of the 27th and morning of the 28th of September, 1870; "while at Alton, Illinois, great numbers of them were seen passing in a southwest direction on the last day of October of the same year." I have elsewhere referred to the "continuous line of passing butterflies flying in a direct course toward the south" observed from the top of Pegan Hill in Natick by William Edwards. His full account, which leaves scarcely a doubt that they belonged to this species, may well find a place here.

The day was warm and summer-like, with no wind to disturb the flight of the butterflies, which was remarkably steady and even, like the flight of migrating birds, and very unlike the usual zigzag movement of butterflies. We watched them for nearly an hour as they appeared in view from the north and moved steadily onward toward the south. Sometimes they appeared singly, sometimes in groups of three or four, but oftener in pairs, and flying six or eight feet apart. Being anxious to obtain a specimen, that the species might be determined, we made several vain attempts to bring one down by sending our walking-sticks after them. This put them in great confusion, entirely breaking up their line of march, and causing them to dodge rapidly to the right and left, and frequently to drop down several feet; although they continued on at the same rate of speed, they seemed unable to regain their former even flight, but kept up this zigzag motion till lost sight of in the distance. They were apparently one of our largest species, and were visible at least one eighth of a mile as they appeared in sight; it seems an important fact that they did not change their altitude in passing over the hill. We also noticed when descending the hill toward the north that they were flying at the same level till we were so far below them that they appeared but mere specks in the air above our heads, and before we had reached the plains below we had entirely lost sight of them. There was no reason to suppose that the butterflies changed their course in order to pass over this hill, or that the flight did not extend over the surrounding country. (Am. nat., xi: 244.)

In a letter written by Miss Jennie Murray of Girard, Kansas, to Dr. A. S. Packard, which he has kindly permitted me to see, she records a similar passage on September 17, 1877. The butterflies came, she writes two days afterward, "from the north north-east at the rate of about twenty a minute, and continued from the time I first noticed them for about half an hour. It was between five and six o'clock P. M. I was told the same thing occurred here last fall. Some were as high up as the eye could reach; others lower; and still others not more than twenty or thirty feet from the ground." Specimens were in this case obtained and identified. In an unsigned note in *Field and forest* (iii: 91) it is stated that "large numbers of this butterfly commenced their flight over Denton Co., Texas, about the 15th of October, and continued up to November 5th, the last week, however, in much smaller numbers than previously. They seemed to be moving in a southerly direction and were accompanied

by about a dozen other species of smaller butterflies." Finally, I was myself fortunate enough to observe a movement of this sort during the autumn of 1888 between nine and ten o'clock in the morning of September 2; while sitting on the piazza of a house facing the sea-shore at Hampton, N. H., and only a stone's throw from the water. a continuous stream of these butterflies passed before me toward the southwest, following the line of the sea-coast, with the wind about northwest. There were never less than three or four directly in front of me, often a dozen or twenty. In the hour that I watched them, I calculated that at least fifteen hundred passed me and without a single exception in the same direction.

Mr. Roland Thaxter, who found great swarms of this butterfly festooning the trees in a pine grove in northern Florida (as detailed further on), says he "was told by Dr. A. W. Chapman"—the most competent authority living—"that there was hardly milk weed enough in all Florida to produce one of these flocks." Moreover, Dr. Chapman states that in Apalachicola the butterflies are very abundant annually from November until May; after that but few are seen until fresh ones appear in the middle of October. Flocks, too, have since been observed in Florida, wanderers no doubt from the north, like our invalids, seeking a climate best permitting hibernation. And in these facts we find an explanation of these migrations. All or nearly all are descendants of those which at the end of the previous season flew to warmer climes and dispersed in the spring in search of milk weed. The same was true of their ancestors of a corresponding time of year, the rugged season having eliminated the greater number of those which, when the autumnal season warned, stayed behind, so that they left no descendants. In this way an instinct, an inherited tendency, grew up, which is probably annual and nearly if not quite universal, but to which our attention is drawn only in those years in which the species is superabundant.

Commercial extension in recent years. Among the most interesting points in the distribution of this butterfly is the fact that within thirty years or a little more, it has begun to invade so many regions of the world as to make one think at first blush that it may some day vie with *Vanessa cardui* in cosmopolitan character. The facts concerning its exotic distribution, so far as I have been able to gather them are as follows: It first reached the Hawaiian Islands, fully two thousand miles distant from America, sometime not far from 1845 to 1850. At any rate we have the direct statement of Dr. Luther H. Gulick who was born upon the islands, that in 1852, after eleven years' absence, he returned to the islands, and his brother drew his attention to the fact that *Asclepias* had been introduced during his absence and had already become a troublesome weed; that his brother had noticed that wherever the milk weed appeared, there also *Anosia* made its advent, a butterfly unknown until after the milk weed

had been introduced. We next find it 1857 as far away as the Island of Ponape, one of the Caroline Islands in Micronesia, a distance of another two thousand miles or so from the Hawaiian Islands. This fact we also owe to Dr. Gulick's personal testimony. He was for some time a resident of Ponape, and the butterfly was first seen by him in the year mentioned, not long after he had discovered several young milk weeds which had sprung up in earth in which various other plants had been brought from the Hawaiian Islands in a Wardian case. The plants were brought in a missionary vessel which sailed from Honolulu, and on its way to Ponape touched only at Apaiang of the Gilbert Islands and Ebon of the Marshall Group, both low coral atolls, and at Kusaie which is of basaltic formation and richly clothed with verdure, but where the butterfly did not then occur. It is evidently impossible that in a voyage consisting in the whole of fifty-four days, the insect in any stage or stages could have been transported in the Wardian case itself, for it easily undergoes all its transformations in warm regions in a month or five weeks at most. If the butterflies were introduced at that time, as there is every reason to believe from Dr. Gulick's accounts, there seems no other supposition possible than that an impregnated female flew into the hold of the vessel while lading at Honolulu, and was carried perforce to Ponape; or, possibly, a pair of butterflies. It would certainly be absurd to suppose that a gravid female could have flown over two or three thousand miles of ocean, and in addition have appeared in Ascension Island almost simultaneously with a few plants of *Asclepias*. As the butterflies pass the entire winter in hibernation and then lay eggs in the spring, there is nothing in any way really surprising in Dr. Gulick's statements, unless it be impossible for an impregnated female to live in enforced hibernation a couple of months without laying; when it would be necessary to suppose a pair to have been transported, which would of course be more extraordinary.

Granting our explanation to be just, it is highly probable that it was from this single ancestor, or pair, that the swarms which have now spread over the entire South Seas, in many of which it is the commonest butterfly known, have sprung. Our knowledge of the period and extent of this later distribution we owe largely to Professor Semper, who states that the butterfly was first seen in 1863 by Captain Rachan, one of numerous collectors of the Museum Godefroy, on the islands of the Tonga or Friendly group, again nearly another 2000 miles from Ponape. The first specimen actually obtained was secured in 1866 on Niuaufu; one of the islands of this group, and in the same year larvae were discovered on *Asclepias curassavica*, a plant now spread quite as far as the *Anosia*. We now begin to be able to record in part the rapidity of its spread; for it was first seen in Tutuilla, one of the islands of the neighboring Samoan group, in 1867, but upon Upolu and Savaii, islands of the same Samoan

group, distant at the nearest some fifty miles, not until 1869. Yet in Upolu it became one of the commonest butterflies in 1870. It was not until 1868 that it was discovered at Tongabalu, one of the southern of the Tonga Islands, but in the same year it was seen in the open sea five hundred nautical miles to the southeast. In 1869 it had appeared at Roratonga, one of the Hervey Islands, five hundred miles or more away. In 1870 to 1872 it was found on Huahine and Tahiti of the Society Islands, again five hundred miles or more distant. So far the account of Professor Semper. But Mr. James J. Walker, who sailed in the South Seas in 1883 and found *Anosia* nearly everywhere one of the commonest butterflies, states that he was informed at the Marquesas Islands, which lie to the northeast of the Society Islands, again at the distance of some five hundred miles, by a Roman Catholic missionary residing there forty years, that he distinctly remembered seeing the first specimen there about the year 1860; it should be noted that the Marquesas Islands are nearly as distant in a southeasterly direction from the Hawaiian Islands as the Carolines are to the southwest. Mr. Walker also found the butterfly on the Hervey and Society Islands and at Oparo, one of the Andaman group, in 28° south latitude, though it had not then reached Pitcairn Island, which lies much farther east and somewhat farther north. These statistics indicate its movements from the Caroline Islands in an easterly and southeasterly direction, but it has also left its marks by the way, in a southward extension from this route of travel. For it has reached Waigiou, New Britain, New Ireland, New Guinea, the Louisiade Islands, every part of Solomon and New Hebrides groups, the Duke of York Island, the Loyalty and Fiji Islands, New Caledonia, Norfolk Island, the northern island of New Zealand, the entire eastern coast of Australia, from Cape York southward even as far as Hobart Town in Tasmania. It reached Lord Howe Islands in 1870, Clarence River on the opposite coast of Australia, in 1871, Melbourne in 1872 and has now extended even to Celebes, and according to Kirby, to Java.

It thus appears that it now possesses a territory in the Pacific Ocean of at least 110° of longitude and 65° of latitude. But this is by no means all. It has moved also in some strange way in the opposite direction from the American continent. It has long been known in the Bermudas as one of the extremely few butterflies to be found on that island. Specimens now in the collection of Godman and Salvin were taken in 1864 in the islands of Fayal and Flores, but it seems not to have been since recorded from the Azores. It has, however, made its appearance on the continent of Europe at La Vendée on the Atlantic coast of France, and a number of instances of its capture in England have been signalized within the last ten years. These instances are so numerous and recorded for so many different years that it would seem highly probable that the butterfly has been

endeavoring to maintain a foot hold ever since 1876 when the first instance of its occurrence was recorded. The first specimen was found at Neath in South Wales in September, a second one in Sussex in the same month, and a third at Hayward's Heath in October. In 1877 one was taken at Poole Harbor. In this year also a specimen was taken upon the continent. It did not appear again till 1881 when a specimen was taken in Kent in September. Again in 1884 one was taken in the Isle of Wight. In August and September, 1885, nine specimens were taken in the counties of Dorset, Devon, Cornwall, and the Isle of Wight. It was again taken in 1886 in the south of England, in Guernsey, at Gibraltar, and in Portugal.

I have spoken of this extension of its natural region as one due to commercial agencies, because it would seem that the distance to which the insect has been carried must be due to something more than its very remarkable powers of flight. The fact that the butter fly has been seen flying at sea five hundred miles from land is a sufficient proof of the latter, and we should be far from questioning its power to compass with no very great difficulty one-half the extreme distances to which we know it has been carried without power of alighting. But that this should occur with a female heavy with eggs (and no other supposition would permit us to understand its subsequent propagation in the regions visited) is past credence; more especially as we have in the instance of its transport from the Hawaiian Islands to the Caroline group an almost certain proof of the method of its transport, through artificial aid. The alighting of one of these butterflies laden with fertile eggs upon some part of a vessel or within its hold would by no means be a strange occurrence; and this is all that is necessary to explain its transport over the wider regions. That, having once established itself in one of the Micronesian Islands, it could easily spread over the whole of Polynesia through the insect's ordinary power of flight will not be questioned. But that this has taken place not only within historic times, but within the last twenty or thirty years, as has been shown by Semper, is an almost direct proof that its first introduction to the South Seas was by artificial means; for if it could be brought about solely by the power of flight of the insect, aided by the natural currents of the air, it would have happened long ago; and the fact that the insect has been able to establish itself wherever it chose when it got a foot hold and that it has not until a very recent period so established itself, are sufficient proofs that commercial agencies, so much more abundant in later times than formerly, have been the great means of introducing these butterflies to the islands of the Pacific. It is highly probable that it owed its first introduction to the Hawaiian Islands to similar agencies, and that its appearance in Europe is due to the same cause.

Occurrence in New England. *Archippus* occurs throughout New England, but is much more rare in the northern than in the southern part; though even in the latter it can hardly be called abundant, for usually specimens must be captured singly. Yet now and again it swarms, as in the autumn of 1871. In some localities it is especially numerous; such places, for instance, as islands off the coast, or broad, sandy sea beaches, where *no* *Asclepias* grows. Is it that an innate propensity for geographical extension leads this butterfly to the last possible limit? Mr. Thaxter once found it in great numbers on Appledore, the largest of the Isles of Shoals, N. H., which has a surface of about five hundred acres; yet there was then no trace of milk weed upon any of those islands, which he has explored thoroughly. Again, on Fire Island beach, Long Island, during the last of August, 1870, Prof. S. I. Smith found this butterfly in thousands wherever flowers occurred, while they were uncommon on Long Island itself. He counted eighty on a single small plant of *Erechthites*, and yet looked in vain for *Asclepias*. See also on a succeeding page Dr. Hamilton's account of their abundance at Brigantine Beach, N. J., equally barren of *Asclepias*.

Haunts and swarms. The butterflies occur in open ground, in meadows and pastures and not infrequently in gardens. Mr. Wallace gives a similar account of their haunts in the Amazons valley, describing them as "open grounds, dry and barren places"; but when the butterflies congregate, as seen above, they seek the branches of trees. "In the evening and in cloudy weather they are found resting on the stems of herbaceous plants; they never are to be found in the thick part of the woods, but are common in the open spaces of the forests, and prefer meadows and plantations; . . . [they are] abundant even in the largest towns of the middle and northern states (Doubleday, *Gen. diurn. Lep.*, i: 90).

The species of this group are known all over the world for their richness in individuals, and ours is no exception to the rule; the large size of the insects makes the fact the more conspicuous. In the western prairies they may be found in myriads.

Thus Mr. J. A. Allen (*Trans. Chic. acad. sc.*, i: 331) writing from Iowa says:—

This extremely abundant butterfly seems to prefer the open prairie, but is driven to the groves by the winds which sweep furiously over the prairies in the summer months, and especially in September; here the butterflies are collected in such vast numbers on the lee sides of trees, and particularly on the lower branches, as almost to hide the foliage, and give to the trees their own peculiar color. This was not seen in one grove alone, but in all of those which were visited about the middle of September. If unmolested, they remained quietly on the trees; if disturbed by blows upon the trunk or branches of the tree, they would rise like a flock of birds, but immediately settle again, either on a contiguous tree or upon higher branches of the same. At New Jefferson, a little later in the year, when the gales had abated, they were seen

leaving the groves in vast flocks, and scattering through the air almost beyond reach of the eye.

This was, I believe, the first published account of the immense abundance and congregating propensities of this butterfly; but numerous additions to this part of our literature were speedily made. Thus Mr. Saunders described (*Can. ent.*, iii: 156-157) a somewhat similar flock in 1871, much nearer New England, and the same year it was observed in New England itself by Mr. P. S. Sprague. Mr. Saunders writes:—

It was about nine o'clock in the morning when, passing a group of trees forming a rude semicircle on the edge of a wood facing the lake, the leaves attracted attention: they seeming possessed of unusual motion, and displayed fitful patches of brilliant red. On alighting, a nearer approach revealed the presence of vast numbers—I might safely say millions—of these butterflies clustering everywhere. I counted a small space, about the size of my two hands, on one of the trees, and there were thirty-two butterflies suspended on it, and the whole group of trees was hung in a similar manner. When disturbed, they flew up in immense numbers, filling the air, and after floating about a short time, gradually settled again. There appeared to be nothing on the trees to attract them, yet when undisturbed they appeared at this time to prefer resting in quiet, as if enjoying the presence of congenial society.

Mr. Lintner, in writing of this butterfly, from Albany, N. Y., the same year, says:—

I have heard of its abundance in every direction about us, both in this and the neighboring states. At Schoharie I was able to count twenty on the wing at once, driven up by passing wagons from the damp ground on which they were resting. About the 25th of August they were most numerous; in one field of buckwheat which I passed, in returning to Albany, I presume there were a thousand feeding from the blossoms or flying over them. They seem to be of a social disposition, for a friend told me that he had seen large numbers congregated on a small branch of a pine in a grove at Schoharie, the outer ones crowding those adjoining, as if to get as near as possible.

Mr. Riley (3d Report. *Ins. Mo.*, 151) mentions a swarm seen in April by Mr. Thomas Wells at Manhattan, Kansas, which came rapidly with a strong wind from the northwest, and filled the atmosphere for more than an hour, sometimes so as to eclipse the light; other similar statements will be found in Mr. Riley's Third Report.

Mr. Roland Thaxter tells how, while spending the winter of 1875-76 in Apalachicola, Fla., he

found one of these archippus swarms in a pine grove not far from the town. The trees were literally festooned with butterflies within an area of about an acre, and they were clustered so thickly that the trees seemed to be covered with dead leaves. . . . Upon shaking some of the trees a cloud of butterflies flew off, and the flapping of their wings was distinctly audible. They hung in rows (often double) on the lower dead branches, and in bunches on the needles. (*Can. ent.*, xii: 38.)

“On a little fork about a foot long,” he writes me, he counted thirty-seven. Dr. John Hamilton gives a startling account of their numbers in September, 1885, at Brigantine Beach, New Jersey:—

The multitude of this butterfly that assembled here the first week in September is

almost past belief. Millions is but feebly expressive;—miles of them is no exaggeration. On the island is a strip of ground from 150 to 400 yards wide, and about two and one-half miles in length, overgrown with *Myrica cerifera*. After three o'clock these butterflies, coming from all directions, began to settle on the bushes, and by evening every available twig was occupied. To see such multitudes at rest, all suspended from the lower sides of the limbs, side by side, as is their well known custom, was something well worth seeing. One evening I travelled more than half the distance of their encampment, and learned that it extended the whole length and breadth of the bushes. In the morning they gradually separated and did not appear unusually numerous during the day, but in the afternoon they came again as described. I found them on the second, the day of my arrival, as related above, and this was repeated daily till the sixth, the forenoon of which was rather calm and sultry. A storm of wind and rain came on about two o'clock, P. M., continuing till midnight. The next afternoon few came to camp; the great army had disappeared. But how? when? where to? During the next few days they appeared again in considerable numbers—about as they had been observed in former Septembers,—but insignificant when compared with those that preceded. The males and females were about equal in numbers. Not a single stalk of their food plant (*Asclepias*) grows on the island. (Can. ent., xvii: 204.)

Mr. J. A. Moffat, of Hamilton, Ont., describes what he saw of these butterflies while away from home, but in what locality or at what season he does not inform his readers:—

Several years ago I saw them congregating in a bit of woods in the neighborhood of the city which I was visiting at the time. . . . They were hanging in a listless kind of manner to the under side of branches in immense numbers, with their wings closed, and not noticeable unless disturbed, very few being on the wing. Their favorite resting place seemed to be dead pine twigs, which would be drooping with their weight, and in more than one instance I saw one too many light, and the twig snap and send a dozen or more into the air to seek for another perch. (Can. ent., xii: 37.)

Afterwards, describing more particularly some of the details, he remarks:—

There was a general uneasiness pervading the whole flock, rather difficult to describe. It did not come from a working of the wings, but of the feet, as if the foothold was not good, and they were trying to secure a better, which produced a rocking motion, whilst continuously throughout the swarm one and another was dropping off to make for the edge of the woods and join in the grand procession. (Can. ent., xx: 138.)

Dr. C. C. Abbott, one of the happiest observers of the ways and whims of our native animals, writes thus from his New Jersey home:—

An acre or two of neglected meadow reaches to the creek's shore, a half mile distant, and now it is brow deep in boneset. It was scarcely penetrable, and a paradise for butterflies and bees. . . . A small sassafras sapling was so covered [with the milk weed butterfly] that they appeared to outnumber the leaves, and gave the tree a prematurely frost-bitten appearance. I cautiously drew near, and counted one hundred and seven of them, and there were almost as many more. Then giving the tree a vigorous shaking they all took flight, and made a distinct rustling noise as they did so. They did not mount the air to any height, but scattered over the snowy boneset blossoms, and reminded me of an October shower of painted leaves.

A migration of what was unquestionably this species of butterfly took place near by, in September of 1881. They flew at a height of probably two hundred yards only, and moved in a long, narrow body, that took an hour to pass a given point. The migration is known to have extended twenty-five miles and if the direction was not changed,

or the journey ended, a few hours would have brought them to the sea (Waste-land wanderings, 79-80).

The butterfly was again abundant and seen in swarms in New England last autumn (1888), although exceptionally scarce in the spring of the same year. Miss Harrington relates that while walking from the woods to the seashore at Magnolia, Mass., shortly before 4 P. M., on August 29, 1888, she and her companions noticed a great many of these butterflies "flying about in a restless way, but mostly toward the wood; we stepped in from the road a few feet, and there on the oak trees were swarms of them. Some of the branches were literally covered with them; having once lighted they seemed quiet, but thousands, it seemed to us, were still flying about." The butterflies were flying in a westerly direction, possibly a little south of west, with a westerly breeze, the sky being overcast and the day cool. A fisherman in the vicinity said they had swarmed on the young shoots of the willows so as to damage them not a little. Four days later than this, at Hampton, N. H., a little north of Magnolia, I observed the passage of this butterfly toward the south, already described, but discovered no sign of them in the neighboring woods I visited for the purpose.

Oviposition. The early eggs are usually laid near the base of the midrib of either surface of the terminal or next to the terminal leaves of the young plant while they are still erect or nearly erect. The under surface seems to be preferred. Generally but one egg will be found on a leaf, and not often more than two or three on a plant. Later they are also laid upon the pedicel of the flower. The egg hatches in four days or even slightly less, but is sometimes delayed so as not to emerge for five days or more.

Food plants. The caterpillar feeds upon different species of *Asclepias*, although "it shows a wonderful dislike," Mr. Riley remarks, "to the poke milk weed (*A. phytolaccoides* Pursh); . . . larvae furnished with this plant would wander about their breeding cages day after day, and would eventually die rather than touch it"; in the north it generally appears to confine itself to *A. cornuti* Dec., but has been found on *A. purpurascens* Linn. and *A. incarnata* Linn.; in the south and in Missouri, it also feeds on the butterfly weed, *A. tuberosa* Linn., *A. amplexicaulis* Michx., *A. tomentosa* Ell., and *A. curassavica* Linn. and has been taken in Cuba by Dr. Gundlach on *A. nivea* Linn. It has been discovered, too, on the neighboring genus *Apocynum*—*A. androsaemifolium* Linn. (Saunders), and according to Coquillett feeds also on *Acerates*.

Habits of the caterpillar. On escaping from the egg, the caterpillar completely devours the shell and then attacks the leaf, eating a slender hole often entirely through it, and when it has done feeding retires to the concealed side of the leaf; if it is still erect, to the inner, that is the upper,

side ; if extended horizontally, to the lower surface. If, however, it has been born late in the season on a flower pedicel it attacks the flowers themselves and eats down into the ovaries at first, not attacking the leaves until later. The caterpillar eats voraciously, and ordinarily matures rapidly. Dr. Harris says it lives but a fortnight in the larval state, casting its skin three times ; the latter statement is corroborated by Riley, but contradicted by Edwards, whose observations entirely agree with mine, that there are four moults. Sometimes, however, it takes it three or more weeks to attain its growth. Looked for toward evening it will ordinarily be found quiet, apparently resting for the night, planted on the under surface of the midrib of a leaf, half way between the base and apex, its head outward ; from this it might appear that it fed only by day, but some caged specimens certainly did eat at night, and I have found it resting early in the morning on the top of the leaves on a cloudy day ; it is almost always found near the top of a plant, and when disturbed, so as to be knocked off a leaf, the caterpillar coils like a galley worm. Dewitz, writing of the larva in Venezuela, says it spins a thread on being seized, but I cannot understand the statement ; it spins less thread than almost any caterpillar known to me. When walking, the anterior filaments are alternately moved forward, so far that they nearly touch the ground. While feeding they are nervously twitched backward and forward ; and when the caterpillar is alarmed, the movement, though no more rapid, is of much greater violence, the filaments nearly touching the body.

My attention was attracted one morning to one of these caterpillars while moulting its skin ; it had been stationary at least twenty-four hours ; and now first began swaying its body from side to side, falling over so far that the thoracic filament of the upper side became perpendicular, and then drawing itself forcibly back to an opposite position ; the muscular effort caused a considerable indentation along the falling side of the swaying larva at the point where the white band widens, and at which muscles are attached. The motion was repeated about once in three seconds and continued for nearly three-quarters of an hour ; now and then the larva would violently shake its filaments or strain forward the front of the thoracic segments, thus gradually detaching the old skin from the new ; at last, after remaining quiet, as if to gather strength for a final effort, it began to make violent contortions, especially about the thoracic regions, which at first seemed ineffectual, but suddenly the integument parted between the head and body, and, by the movements of the larva, passed backward over the new skin, slipping over the whole body at once and leaving a little empty pellicle at the hinder extremity. The skin was with difficulty removed from the filaments, especially from one whose tip had been bent in the former stage, and which only parted after strong exertions ; the fresh filaments lay limp along the back until they were

gradually drawn forward, the tip clinging to the moist body until the last; but they did not regain their full elasticity for some time. The remaining process scarcely lasted a minute; the head, however, still remained attached and was only removed after repeated lateral abrasions and violent efforts with the front legs. After these efforts, the insect remained quiet, resuming the same attitude, with bent head, which it had taken before moulting, awaiting undoubtedly the hardening of its integuments, and it was nearly two hours before the colors of the head became bright and fixed; the larva then first devoured all the old pellicle, except the head, and afterward moved off in search of daintier diet.

The chrysalis and pupation. The chrysalis usually hangs for about twelve days, ranging in New England generally from nine to fifteen, but in the south, according to Edwards, from five to fifteen; in one case he reports it was reduced to two days! On the other hand Gundlach says it hangs from eight to twelve days in Cuba, and Dewitz gives twelve days as the season in Venezuela. I have known it to be extended here to three weeks. I once tried an experiment with a chrysalis in the middle of August in a room where a carefully graded thermometer registered 68.25° F. Placing the chrysalis next the bulb of the inclined thermometer the mercury rose to 68.5°, and on the removal of the chrysalis it fell again to its former reading.

The chrysalis is a beautiful object and as it hangs pendant from some old fence board, or from the under side of an *Asclepias* leaf, it reminds one of some large eardrop; but though the jeweller could successfully imitate the form, he might well despair of ever reproducing the clear pale green, and the ivory black and golden marks which so characterize it. (Riley, loc. cit.)

Mr. Gosse in writing of the metamorphosis of this species says (Letters from Alabama, 186-7):—

The change of form which the envolved pupa undergoes is most conspicuous in the suspended butterflies; and I have never seen it more remarkable than in this of the archippus, although I have observed the metamorphosis of many species. . . . In this case the abdominal segments were at first much elongated, being distinctly separable, as in the caterpillar; those of the thorax, on the contrary, were contracted, while the wings were small, thick and wrinkled; their extremities being free, for a purpose we shall soon discover. The whole skin was soft, moist and pulpy, and the color bright green, with alternate yellow bands. In a few hours, the abdominal segments had contracted into the form of a smooth, blunt cone, all traces of the divisions being lost, except where a fine line, scarcely perceptible, marked their position; the thoracic segments had much lengthened, and the wings now occupied the half of the entire length; their tips, which before were free, had stretched beyond their first boundary, far over the abdomen, and were now fixed in the general outline. The whole surface was become tense, hard and glossy, and the hue a uniform greenish white.

In describing the final changes of the chrysalis, Peale says (Lep. Amer.):—

On the tenth day, the golden spots begin to lose their brilliancy and the beautiful

green disappears; the orange wings of the imprisoned butterfly now become visible through its temporary sarcophagus, which it bursts open on the following day and the liberated insect soon takes wing to join its comrades, select its mate, and pass the happy hours of a brief existence in revelling in the sweets of the flowers, among which it sprang into being. [Speaking of the period of the chrysalis he further says:] It is only during the summer that the chrysalis is gorgeously arrayed; for by one of those wise provisions of nature, which so often are obvious to the student of her works, it has been decreed that the green and gold shall be sported only whilst the prevalence of verdure serves to guard the insect in its most helpless state, from the analogy of colors.

Life history. This butterfly passes the winter in the imago state. In southern latitudes, according to Edwards, who has given it closest attention, it appears early in the spring and lays eggs upon the milk weed just out of the ground, beginning in West Virginia in the early part of May. The insect matures there very rapidly, and passes through several generations, according to Mr. Edwards at least three, and probably four, in the course of the season, the latest brood of the butterflies hibernating. Riley, who was first to give a tolerably full life history of the insect, claimed that in Missouri it was double brooded, the broods appearing in the latter half of June and in October. In New England, however, what we can learn of the butterfly indicates a somewhat different history. Some years ago in publishing an account of its history here, I claimed that the insect was only single brooded, first coming out of hibernation at the end of June and early in July, laying eggs for a month or so, and the butterflies from these eggs hibernating. A great many points concerning its history both here and elsewhere have been brought out since then and the facts as we know them at present may probably be interpreted somewhat in this way.

The butterflies, which are far more numerous in the late autumn than at any other time, seek winter quarters to hibernate, either by migrating southward or by hiding on our own territory, but with very rare exceptions, north of the natural division line of the Canadian and Alleghanian faunas, and even to a considerable distance to the south of this, say at the line of the restricted northern limits of the latter, possibly sometimes throughout the entire district of New England, every single specimen that remains with us perishes. Now and then an old and battered female may be found in the month of May, but we have actually on record as far as I can discover but two or three instances of this, and one of these is not specific. Mr. F. H. Sprague has a record of one specimen seen near Boston, May 9, 1880. A female much worn and faded was found May 12 at Amherst by Professor Parker, and in another year they were found by Mr. W. D. Marsh on May 15 and May 21 at the same place; while Mr. Caulfield speaks in general terms* of the appearance of butterflies in

* I believe this last a mistake.

Montreal in May. In the extreme southern portions of New England and the neighboring districts, we have not infrequent appearances of hibernating butterflies early in May. But neither hibernators nor their progeny in the preparatory stages,—the only absolutely certain proof of an early brood,—are, with possibly rare exceptions, to be found in the northern half or more of New England, either in May or early in June. The first occurrence of the insect there in any form is much later in the season, generally by the middle of June, occasionally by the very first, sometimes not until the very end of this month, when fine fresh butterflies make their appearance, at about the same time as, or a trifle later than the advent a little further south of the first fresh brood of butterflies from eggs of the same season, thus giving all the appearance throughout New England of an identical swarm of butterflies, varying in time from those found next the southern borders of New England only so much as would be expected from latitude.

This brood is in my opinion to be accounted for only on the supposition that they are *colonists from the south*, which have flown to more northern districts from that impulse to wander which is one of the psychological characteristics of this butterfly. This hypothesis is further supported by the essentially tropical nature of the butterfly, which would prevent its establishing itself as a permanent resident rather than as an annual visitor of northern districts; by its well-known vast power of flight, of which illustrations have been given; as well as by its comparative history in the south and by the known autumn migrations of the butterfly in the opposite direction, of which we have given proof. These butterflies begin in New England to lay their eggs usually in the first week in July, but occasionally as early as the middle of June. Dr. Harris records some caterpillars found on the 28th of June which had reached the length of an inch on the 5th of July, and I have found them in Shirley, Mass., of the length of six millimetres, therefore probably in the second stage, on the 22d of June. These were unusually early caterpillars of the brood which had flown from the south and which sometimes makes its advent early in June. Both Mr. F. H. Sprague and myself have found them about Boston as early as the 2d of this month in good condition, and single additional specimens were found in the same year by Mr. Sprague on the 9th and 15th of June.* They never, however, become at all abundant before the first week in July, when the eggs are ordinarily laid. The eggs continue

* Since this account of the life history was first published (*Psyche*, v: 63) Mr. Sprague observed a single butterfly on May 30 in a "perfectly fresh condition"; and as during the same season (1888) no *Asclepias* was *out of the ground* in the vicinity of Boston before May 20th, it is evident that either it had flown from the south, as I believe, or that it

passed the winter unscathed, as I think never happens, from all accounts. The season was backward this year. May 25 I saw the first young plants in a patch of *Asclepias* in a sunny spot on a lawn which I had examined every two days for a fortnight, and a comparison with other spots makes me confident of the statement above.

to be laid throughout this entire month without any interruption and, with less frequency, throughout a considerable part, sometimes the whole of August.

As regards the later history of this butterfly in the north, we are still somewhat in doubt. Mr. Edwards urges with great pertinacity that the behavior of the butterfly in the north is altogether parallel to its behavior in the south, but this would hardly seem as yet to be settled; at any rate the appearance of the latest fresh butterflies of the season may easily be accounted for on the supposition that they were produced from eggs laid by the older females of the first brood of colonists. For the observer will notice that eggs are laid by butterflies both in a fairly fresh condition and also by those which have been upon the wing a long time, and the closest observations I have been able to give through many summers, both of butterflies seen in the act of depositing their eggs and of the contents of the ovaries of others, lead me strongly to the conviction that this butterfly requires more than a brief time for oviposition, the eggs maturing by degrees and not being fully laid until the butterfly has been upon the wing at least an entire month. The examination of butterflies fresh from the chrysalis shows that the eggs are never entirely mature at this time, while on the other hand these butterflies retain their freshness of appearance for a longer time than usual after they have come from the chrysalis. That there is easily time for a second brood of butterflies from the eggs laid by the progeny of the first colonists (basing our judgment upon the facts as given us by Mr. Edwards in the south) there can be little doubt, but the proof of such a second brood has yet to be given. While, therefore, I am compelled by the facts that have been advanced since my first account of this species was published (1875) to modify my statement in one respect, I am still inclined to think it in the main correct, viz. that this butterfly is normally single brooded throughout the larger part of New England, but that it requires an annual visitation of colonists from the south to exist at all, the hibernating butterflies perishing annually, almost to an individual.

Mr. Edwards entertains a different opinion regarding its life history in New England, and does not believe that the butterflies which have hibernated perish to any such extent as I have presumed; and, because single instances of hibernating butterflies have been found in Massachusetts, he considers that "this settles the matter." But he fails to take note of the fact that Amherst, the only place in which these hibernating butterflies have yet been found in so northern a latitude as Massachusetts, is in the Connecticut valley, where the isotherms trend northward, and which is but a comparatively short distance north of those regions in southern Connecticut, in the valley of the same river, where it is not improbable that hibernating butterflies may be found in all favorable years; nor is he, per-

haps, aware that the valley of this river is one in which southern butterflies find their way farther north than at any other point in New England, excepting in some instances along the seaboard.

My own collecting in New England, where this butterfly is much less common than further south, leads me to believe that it is far easier to obtain it by search for the caterpillar on the leaves of *Asclepias*, than by capture upon the wing; and I would rather decide upon the presence of butterflies in any particular district by a search for plants of *Asclepias* in suitable spots than by watching for the butterflies; so that the failure year after year to find such larvae on young and tender plants in the very spots which are invariably chosen by the July butterfly whereon to deposit its eggs, is to me very strong proof that the butterfly does not ordinarily exist in any form during the early months of the year in regions that I have searched. Regarding the later broods it may be added that the observations of Mr. Marsh, who raised butterflies as late as the latter half of October and even in November, were made, in part at least, upon housed larvae, and that at this late epoch of the year the transformations of the insect are very much slower than they are earlier in the season. Thus Mr. Marsh himself states that the pupal period in October is about three weeks, while in September it is only about a fortnight. In midsummer it is about ten to twelve days.

Mr. Edwards, accepting a suggestion of Mr. Marsh, further urges that the failure to discover the hibernators in the spring is due to their rarity in the autumn, and the latter from the fact that in New England the fields are often mowed for a second crop, and that with the hay great quantities of milk weed are cut down. But aside from the fact that the larger part of the milk weeds inhabited by the caterpillars are found by the side of roads and lanes and in close vicinity to shrubbery, where it is not disturbed by the scythe, there is a single fact which renders this argument absolutely useless, viz., that the imago is usually far more abundant late in the season than at any other time in the year, sometimes swarming to an excessive extent, and found in New England in the same abundance that it is so often found in the west. Yet so far as I have been able to find from inquiries (unfortunately not made at the time) in no instance have hibernators been seen in years immediately succeeding autumns which have witnessed a vast profusion of butterflies, nor have autumns of great abundance been followed by springs of plenty.

In the extreme south the butterflies do not hibernate, but continue on the wing throughout the winter. Mr. Thaxter often observed them pairing in the winter in Florida (Can. ent., xii: 38) while they were in flocks (which he recently writes me were first observed by him January 3, 1876), and although, as before stated, Dr. Chapman finds them rare in Florida from May to November, Gosse in Alabama reports a larva in June, and

in Georgia, Abbot records an imago May 11, from a larva which entered the chrysalis April 25. Mr. Edwards thinks there are at least four successive broods in West Virginia. His statements show that this may be, but not that it is the case.

The following account of its annual history, as seen by an independent observer in southern Ontario, may be of interest here :—

They make their appearance here about the latter part of May, according as the season favors; the first ones are restless and energetic, like males looking for mates; not in the least broken or damaged; not so rich and bright in color as fall specimens, but fairly good withal. In a week or so they become more plentiful and begin to mate, and for a time are scarcely seen but in pairs. Shortly after eggs may be found on the flower clusters of the milk weed, which is not yet in bloom. They never seem to entirely disappear till fall, fresh hatched specimens mingling with the old battered ones of the early season. Their conduct in spring is quite in harmony with that of species which hatch from the chrysalis here. If they hibernated in this locality, I should expect them to put in an appearance a good deal earlier than they do. (Moffat, Can. ent., xx: 137.)

Habits, flight, etc. This insect, as remarked by Dr. Behr, has strong powers of flight; Mr. Bethune states that when crossing Georgian Bay, in Canada, he observed one of these butterflies fifteen or twenty miles from land, and Doubleday says he has frequently seen it “cross the Ohio and Mississippi, when these streams are more than a mile in breadth.” It is also stated (Can. ent., xii: 137) that it has been captured “hundreds of miles from land,” on the Atlantic, and we have already shown that this is but a faint display of its powers. It flies with a slow and sailing motion, usually not far above the ground, hovering fondly over the *Asclepias* blossoms as if it had not lost its juvenile tastes, and, if a female intent on laying an egg, fluttering indecisively around the top of this plant, and invariably settling upon the upper leaves. One may sometimes be observed flying leisurely about one sunny spot which has some attraction for it; it flutters its wings once or twice, and then holding them rigidly at an angle of about 120° apart, floats on the air, swaying a bit to one side or the other, flaps its wings again, and then sails once more with a slightly descending course. If alarmed, it will fly away with considerable swiftness, in a nearly straight course. When in company, the butterflies are often seen at great heights, sporting together. Mr. Saunders speaks of them as “gyrating in a wild manner, at all heights, some so far up that they appeared but as moving specks in the sky, others floating lower, over the tops of the trees, in an apparently aimless manner” (Can. ent., iii: 156).

On the sea shore they have a fondness for following the course of the beach or bluff, as if enjoying the sea view. I have followed one for nearly a mile along the Nantucket bluffs, when it would not vary its course a hundred feet to one side or the other. It is astir until a late hour of the day,

and I have seen it flying within half an hour of sunset. It appears to be most active, says D'Urban (Can. nat., ii:352)

when the atmosphere is charged with electricity, and often, in the death-like calms which precede a thunder-storm in the country, when not a breath of wind ruffles the glassy surface of the water, and the lurid clouds are hurrying up from the horizon, one of these splendid butterflies may be seen floating past on the sultry air, like a herald of the approaching storm.

D'Urban adds in the same place that it had been named to him in his youth as the "storm fritillary"; and if it be really an independent idea, the following quotation from Moffat, read in the same connection, is of particular interest.

I regard it as a particularly interesting creature in every respect; although so common, it is never "vulgar," never in a hurry; it has the easy grace of the leisurely class. I have thought that one who has seen it only in an open country can form but an inadequate conception of the diversity of its movements on the wing. To see one on a bright summer day, when a stiff breeze is blowing, disport itself about the wide-spreading top of a high tree, is a choice pleasure. It seems to fairly revel with delight in a gale; now it rolls and tosses and heaves, always heading against the wind; now it spreads its sails to the breeze, and is hurried violently backward and upward; again it furls them, and, slowly descending and advancing, it describes a variety of the most charmingly graceful curves and waves and undulations imaginable; a thing of beauty to look at, and a joy to think of forever after. Attempts have been made to attach to it common names. I have thought, when watching one at such a time, that "the storm king" would be very appropriate, and quite befitting its regal character. (Can. ent., xx:137.)

When settled and on the alert, the edge of the hind wings rests upon the ground, while the body is raised anteriorly to the height of the length of the middle tibiae and tarsi; the wings are in constant motion, being slowly lowered and rapidly raised, while the antennae, bent downward close to the base, are extended on a line with the body; the latter are nearly straight but a little sinuous, and are divergent at an angle of 100° the club being bent downward and outward, the tips 30 mm. apart. When the butterfly is at complete rest, the wings are tightly closed, overlapping so as to conceal all the brighter parts of the fore wings; the antennae, while retaining the same curve and divergence as before, drop to an angle of about 40° . When settled on a flower, the wings droop heavily.

The butterfly has a curious habit of occasionally moving one of its palps outward over the eyes and back again, while turning its head in the same direction.

Miscellaneous. The butterfly has, as Mr. Riley writes, a rank but not very strong smell. Experiment shows that all the scales have a caroty odor, and that those in the pouch of the hind wings differ from them only in being stronger scented with a slightly honied character. It is well known that this odor or some nauseous taste or both render the insect distasteful to insectivorous creatures, and that they serve, to some degree at

any rate, as a protection. This accounts fully for the frequency with which it is known to swarm. We have already related in its proper place how it has become an object of unconscious mimicry by a butterfly of quite a different group—*Basilarchia archippus*. It has been noticed by Jack that it, and other large butterflies of the same color are persistently followed in their flight by *Phyciodes tharos* and other small, red butterflies as if the mere color were a protection. "They alight when the large butterfly does, rising only when the larger insect takes to flight again."

The tenacity of life of the whole group is remarkable. Trimen tells us that South African species caught, pinched (a common rough way of killing butterflies by collectors) and pinned, would on removal of the pin "fly off in a nonchalant manner as if nothing had happened"; and W. T. Davis records an instance of a pinned chrysalis developing the imago quite as if nothing had happened to it. Louis Mitchell, of Norwich, kept a female in the house until December 10, forty days after her emergence from the chrysalis, by feeding her with sweetened water; and he thinks she would have lived longer but for a wardian case in the room, and as she persisted in keeping near the glass her wings were continually drenched by the moisture collected on it.

Julius Meyer relates how observing one of these butterflies settling itself for the night directly under a flower of *Asclepias* instead of upon its accustomed dry twigs on trees, he drew nearer to observe it, when a hummingbird came to visit the same flower.

Scarcely had I observed it, than out rushed the butterfly and furiously attacked the bird, which in an instant sought safety in precipitate flight, followed closely by the insect till lost to view in the distance. Amazed at so strange a spectacle, I stood upon the spot, gazing in the direction where they had disappeared for some five minutes or more, when to my surprise and pleasure I saw the butterfly coming back, which, when near the flower flew in a wide circuit around it, as if to ascertain whether another enemy had taken possession of it or not. Then lessening its flight it finally ventured upon the flower again; but being much agitated walked nearly all over the plant repeatedly until it finally settled upon its chosen place for its nightly rest. (Bull. Brookl. ent. soc., ii:74.)

Mr. Henry Edwards has observed the butterfly at the electric light.

My son tells me that one afternoon, late in the summer, at about five o'clock, the last specimen of many he had seen flying alighted, apparently for the night, on the withered brown end of a fir twig, which being much nearer its own color than the living green branch, would afford better protection during its rest. The resemblance in color was indeed so close as to attract his attention.

Parasites. It has been generally supposed that the insect was not only free from attack by the higher animals, but from insect foes. This is true only to a limited extent, for, though by no means so harried as are others, it has its fair share of foes. Mr. Riley wrote me, as long ago as

1871, that Mr. Saunders had bred an ichneumon from it, but nothing more is known of it. Mr. C. P. Gillette, however, has bred a *Pteromalus*, *P. archippi* (Can. ent., xx: 133) in considerable numbers, over fifty having been reared from a single pupa. They emerged from the same on September 13. From eggs sent me from West Virginia by Mr. Edwards, I reared several specimens of *Trichogramma intermedium* (89:8); and finally, to round out the forms of parasitism, Dr. Riley years ago found a dipterous parasite (*Mascicera archippivora* (89:18) in the larva, which sometimes is so persistent in its attacks that not one caterpillar in fifty is free from it.

Desiderata. Although this interesting butterfly is one of our best known species, there are several points in dispute regarding it, and many features in its history which need further investigation. The movements of the butterfly in the spring and in the autumn will require systematic and concerted observation over a wide extent of territory before their satisfactory solution can be expected. Where swarms and bexies occur, they should be carefully observed from day to day, and hour to hour, to study the movements and intent of the throng. The whole question of the regular or irregular migration of butterflies can be studied better with this species than with any other in the world, because there is none so subject to congregational movements which is found where so many intelligent observers are stationed. If, as I believe, there is over the entire extent of the country inhabited by it, at least east of the Rocky Mountains and north of the Gulf States, a periodic movement of the butterfly, to the south in the season which corresponds to the end of September in New England, and to the north in the time of the first (and in the middle belt of the second) season of egg laying, then observers ought to note *at these periods* the general direction of movement—not over a few feet or rods, but as far as the eye can follow them—of as many specimens as possible, tabulate them and publish the results. By this means I believe a periodic movement could finally be as well established as the annual migrations of birds; to this work every one can contribute who knows the butterfly by sight.

Then we need many more careful observations on the immunity supposed to be enjoyed by this butterfly in its various stages—an immunity certainly not perfect, and the exact nature and extent of which will reward only patient and conscientious field work. It would be interesting to know the comparative willingness with which insectivorous birds would devour the caterpillar and that of *Papilio polyxenes*, which bears some resemblance to it. The life history, and particularly the number of broods in a season, should be worked out independently in many places, and for several seasons in each, to determine questions in which writers are at variance. For this the condition and abundance of the butterfly should

be observed from week to week, and with it the relative numbers of caterpillars in each stage, tabulating all the facts that can be obtained, including observations of the ovaries of such females as are captured. The following would seem to me an interesting and valuable experiment for some one having access to a green-house empty in summer to try : place together males and females reared from July caterpillars in the northern half of New England, *without other admixture*, in such a green-house, covering the open windows with netting to prevent escape, and placing an abundance of Asclepiads in bloom and in young shoots within. If the butterflies will breed in confinement, then the females should lay eggs, if, as Mr. Edwards believes, there are in this district two broods of butterflies from July on ; they should not lay eggs if, as I believe, there is but a single generation. Coupled with this should be similar experiments further south, where there is more than one brood, to see whether they will breed at all in such confined quarters.

LIST OF ILLUSTRATIONS.—ANOSIA PLEXIPPUS.

General.

Pl. 18, fig. 1. Distribution in North America.
89: 8. Trichogramma intermedium, a parasite.

18. Mascicera archippivora, a dipterous parasite.

Egg.

Pl. 64, fig. 1. Egg, colored.
67: 4. Micropyle.

Caterpillar.

Pl. 62, fig. 6. Internal organs of male, side view.

70: 3. Caterpillar at birth.

74: 5. Full grown caterpillar, colored.

78: 1-5. Front views of head, stages i-v.

86: 1. Main nervous cord.

37. Side view of head.

78: 10. Side view of inferior gland on first thoracic segment.

16. Head viewed from beneath, to show the mouth-parts.

Chrysalis.

Pl. 62, fig. 5. Internal organs of female, side view.

83: 1. Colored.

2. Side view, outline.

3. Dorsal view, outline.

86: 17. Dorsal vessel.

87: 20. Three figures to show the change during pupation, according to the old view.

Imago.

Pl. 1, fig. 7. Male, both surfaces.

16: 10. Upper surface male, plain.

33: 23. End of male abdomen, with false clasp.

24. Male abdominal appendages.

38: 2. Neurulation.

44: 2. Pouch of hind wings of ♂.

3. Cross section of same.

46: 5-10. Scales at edge of pouch and androconia.

52: 2. Side view of head and appendages enlarged, with details of leg structure.

61: 38. Cross section of scale.

45. Cuticular processes on walls of food reservoir.

49. Protrusile fascicle of hairs of male abdomen.

58. Side view of end of abdomen, ♀.

59. The same, ♂.

62: 1. External anatomy of female.

2. Internal organs of female.

3. Reproductive organs of male, dorsal view.

4. The same, side view.

87: 3. Pharyngeal sac and muscles, from above.

5. Pharyngeal sac and related parts, seen from the side.

9. Longitudinal section of maxilla.

23. Cross section of maxilla.

25. Front view of head, denuded.

SUBFAMILY LIBYTHEINAE.

LONG BEAKS.

Libythides and Libytheides Boisd.; Libytheites Blanch.; Lybitheidae Dup.; Libytheitae Luc.; Libytheina Herr.-Schaeff. Hypati (pars) Hübn.; Hypati Scudd. Severi Hübn.

'Tis thine to wander where the rose
 Perfumes the cooling gale.
 To bask upon the sunny bed,
 The damask flower to kiss,
 To range along the bending shade,
 Is all thy little bliss.
 Then flutter still thy silken wings,
 In rich embroidery dressed,
 And sport upon the gale that flings
 Sweet odors from his vest.

TAYLOR.—*To a Butterfly.*

Imago. Butterflies of medium size. Head of moderate size. Front slightly tumid, scarcely protuberant beneath. Antennae inserted each in distinct, entirely disconnected pits, and consisting of from forty to forty-five joints, slender, straight, scaled, a little longer than the abdomen, the club rather ill-defined by the gradual incrassation, but elongated. Palpi exceedingly long and moderately stout at base, heavily beset with long scales.

Thorax moderately stout, not much compressed, upper surface considerably vaulted, a little protuberant in the middle; anterior sides of mesoscutellum gently hollowed, at the apex projecting but little between the halves of the mesoscutum and yet, because of the elevation of the former, forming with each other not much more than a right angle; posterior border well rounded, largely protuberant in the middle; metascutellum very inconspicuous indeed, formed of a triangular piece facing posteriorly, the apex not greatly elevated, and its tip only appearing above; metascuta pretty well developed, protecting the rear of the mesoscutellum and bent strongly in the middle to effect it, the upper border strongly arched.

Fore wings produced to a considerable degree above the median region and strongly angulated, the middle of the outer border very strongly and abruptly excised. Costal nervure terminating at the middle of the costal border; two superior branches of the subcostal nervure emitted before the tip of the cell, the other two beyond,—the inferiors arising much as in the Nymphalinae; discoidal cell nearly half the length of the wing, closed by rather a slender vein; first branch of the median nervure arising somewhat beyond the middle of the cell, the last curving toward the subcostal to which it is connected by a slender vein; internal nervure very slender, running into the submedian at a short distance from the base.

Hind wings subquadrate, the outer border for the greater part nearly straight, but crenulate; the costal margin sometimes lobed apically. Costal nervure terminating nearly as far from the base as the lower outer angle of the fore wings; subcostal nervure apparently taking its rise as a dependent of the costal, its lower branch curving at base toward the median; discoidal cell closed by a very feeble vein uniting the last branch just beyond its curve to the subcostal just beyond the origin of the second branch, directed outward in passing from the subcostal toward the median; the branches of this vein arise farther from the base of the wing than those of the subcostal, the first branch some distance beyond the middle, the last branch curving pretty strongly near the base toward the subcostal; submedian nervure terminating at or before the anal angle; internal nervure terminating before the middle of the inner border, the latter affording a gutter on its basal half for the reception of the abdomen

Fore legs greatly atrophied in the male, the tarsi consisting of a single unarmed joint; but little altered in the female, excepting in size, the armature of the tarsi and particularly of the last joint being nearly complete. Paronychia and pulvilli present; claws very small, falciform.

The structure of the male abdomen is very exceptional among Nymphalidae, the eighth abdominal segment being produced into a median beak-like hook, or a pair of lateral hooks with interlacing bristles between them, concealing the upper organ of the male appendages, which is a slender, acicular process directed backward. Clasps very simple, forming broad, compressed plates, very variable in form, sometimes rounded and entirely concealing the other parts, at other times conforming more closely to the diversified nymphalid type with projecting processes and hooks.*

Egg. Elliptic in form, but slightly or distinctly produced apically, the extreme apex truncate, the sides with many very elevated vertical ribs, traversed, like the surface, by numerous horizontal raised lines.

Mature caterpillar. Cylindrical, unarmed, clothed only with pile arising from tubercular points, the segments with four transverse divisions; markings in longitudinal stripes. Head narrower than the body, globose, smooth, pilose.

Chrysalis. Ovate, compressed, with rounded angles. Head blunt and quadrate, dorsally not separated in outline from the thorax, which is well arched, carinate, and the front of which has an abrupt descent; abdomen cylindrical, but tapering, and mediodorsally carinate; cremaster prominent, elongate.

Characteristics and classification. This anomalous subfamily of Nymphalidae may be readily distinguished by the excessive length of the palpi, which in these butterflies greatly surpass those of any others (being from a quarter to a half as long as the whole body) and by the peculiar angulation of the fore wings, which are strongly and abruptly excised.

The markings, too, are unique; the dark brown of the upper surface, on the basal half of the wings, is more or less obscured by fulvous in longitudinal areas, and the apex of the fore wing is supplied with large oval roundish spots, fulvous or pale in color, transversely or diagonally arranged.

The purpose of such an extraordinary extension of the palpi is not apparent. Edwards, referring to it (Butt. N. A., vol. ii), remarks:—

If they were not pacific little creatures, these butterflies might seem to be furnished with an "engine," as Spenser calls it, to inspire with caution evil-minded foes, such as wasps, dragon-flies, and that "wicked wight," "foe of faire things," the "greisly tyrant spider." . . . And surely the fiercest enemy might hesitate before that portentous beak and those red eyes blazing like carbuncles. Nevertheless I am sorry to have to say that wasps and spiders maintain the mastery, and cause havoc, not only among these, but all butterflies. And dragon-flies (*Libellulæ*) pounce upon them as do hawks on small birds, bearing away their prey to be devoured at leisure.

De Nicéville remarks in his *Butterflies of India* (ii: 301):—

The different species . . . are singularly uniform in size and outline, as well as in colouration, but the specific distinction in the markings of the upperside are clear, and in most cases constant. They all vary from a little under two inches to a little over two inches in expanse; all have the same peculiar outline and strongly falcated fore-

* Its structure in the European species is very insufficiently given by White; and the description given in the *Biologia Centrali-*

americana (purporting to cover more than the single species there introduced) applies only to the American forms.

wing; all have the underside clouded and striated with similar protective colouration, varying in tone in each species but uniform in style throughout [the group]. In all the upperside is brown, bearing on each wing some tawny or whitish marks, and it is by the variations in these markings that the different species are distinguished.

The peculiar structure of the fore legs in this subfamily separate it at once from all other Nymphalidae, they being aborted and brush-like in the male, as is uniformly the case in all Nymphalidae, but normal in the female, that is slender, articulate and fully furnished with appendages. As in this respect they accord with the members of the next subfamily, the English entomologists generally place them in it; but certainly without reason, for this single peculiarity cannot outweigh the mass of structural features which ally it to the other Nymphalidae, including the suspension of the chrysalis and the entire structure of the broad head, which is distinctively nymphalideous. The normal structure of the fore tarsi of the female is what might be looked for in a member of the Nymphalidae most nearly related to the Erycinidae; it would in reality be more surprising if the leap from the normal to the abnormal should be made without some such passage. It is still more to be looked for in a group which shows its further alliance with those below it by the general pieridiform character of the larva, although even here the structure of the head, and its relation to the parts behind are distinctively nymphalideous, and the segments of the body are divided into four and not six subsegments. The attempt of a recent writer (Doherty, Journ. Asiatic soc. Beng., v. ii: 110) to place it directly next the Pierinae, on account of this similarity, and the supposed resemblance of the egg to those of that group, can in no way be defended.

The eggs are described by this author as ampulliform, with a short neck or stalk close to the apex; but, as the accurate figures of our species given by Mr. Edwards and reproduced on our plate show, ours are quite different, so we must suppose some distortion to have been produced in those (of Indian species) seen by Mr. Doherty. They were, he states, "squeezed" from the body of the parent. Those of one American species, on the other hand, are pretty regularly elliptic, with sharply raised, prominent longitudinal ribs, and are thus of an entirely characteristic form. Those of the European species have been described too briefly to characterize them.

The mature larvae differ strikingly from their nearest allies in being naked or simply pilose, closely resembling the caterpillars of the Pierinae in form, clothing and general aspect. The chrysalids hang by the tail like all other Nymphalidae and have the general aspect of the Satyrinae, being devoid of angulated prominences.

We see, therefore, that neither in the egg, the larva nor the chrysalis is there the slightest indication of any special relationship with the Lemoniinae.

If upon examination of the caterpillar just from the egg, this should prove to be unfurnished with ranged chitinous annuli, there would not be a single character drawn from the early stages by which this group could be placed in the *Lycaenidae* rather than in the *Nymphalidae*. Even in the imago the only striking characteristic of its structure which allies it with the *Lemoniinae* is the sexually heteromorphous character of its fore legs,—a character which by itself should certainly not outweigh the numerous characters from the imago itself, by which it is shown to be a member of the family *Nymphalidae*. Furthermore, if it were to be placed with the *Lemoniinae* in the family *Lycaenidae*, it would destroy at once the unity of character belonging to this family. It has no place there.

Transformations and habits. The history of the transformations of the butterflies of this group is imperfectly known. In temperate regions it would appear that there is more than one brood annually; that the butterflies, and in some instances belated chrysalids winter; that in early spring the eggs are laid upon the tender opening leaves of the shoots of *Celtis*; that the caterpillar hangs by a thread for descent from its station, but that if alarmed greatly it will drop to the ground without it; that the transformations are passed pretty rapidly and that later broods lay upon the under surface of leaves. The history of the European species has been confused by the fact that another caterpillar has been wrongly referred to it by Duponchel, Godart and Hübner.

"This small group," says A. R. Wallace (Trans. ent. soc. Lond., 1869, 334) is of world-wide distribution, and like all such is a frequenter of open grounds, plains, river banks and seashores rather than of the virgin forest. The species are small, and in the activity of their motions resemble the lesser *Nymphalinae*." Nicéville says (Butt. Ind., ii: 299) of the Indian species: "I have almost exclusively found them near water. Major Marshall informs me that he has more usually seen them in forest glades." Our own species is said to be a frequenter of roadsides.

Distribution. No other subfamily of butterflies is so poverty-stricken in numbers, scarcely a dozen species being known, and only two or three very closely related genera. This is the more striking from the fact, already alluded to, of their almost world-wide distribution, for the butterflies of this group will be found on every continent; the Old World types are distinct from those of the New, but in all parts of the world they are confined to the tropics and the adjacent countries; the metropolis of the subfamily appears to be the archipelagos and borders of continents lying between India and New Caledonia, but species also occur in the Mauritius, western Africa and on the shores of the Mediterranean; in the New World they are found exclusively in the eastern part of the continent and in the archipelagos lying between the equator and 5° North Latitude. One species has been taken on one or two occasions in New England.

That this group of butterflies is a waning type appears perhaps further from the fact that a fossil has been discovered in Colorado belonging here, and combining in its structure features which distinguish the genera of the Old World and the New. That of the paltry number of fossil butterflies known, one should belong in a group so inconspicuous in numbers in modern times as this, is a very striking fact.

HYPATUS HÜBNER (restr.).

Hypatus Hübn., Catal. Franck, 85 (1825).

Libythea (pars) Auct.

Type.—*Papilio carinenta* Cram.

"Whose butterfly," I said, "are you?
And what sweet thing do you pursue?"

STODDARD.—*The flower of love lies bleeding.*

Imago (54:6). Head of moderate size, abundantly clothed with short, compact hairs. Front moderately full, broadly rounded, scarcely protuberant beneath, advanced slightly in front of the eyes, considerably broader than high, but not so broad as the eyes; upper border descending a little but rather suddenly with rounded edge to the antennal pits, in the middle advanced very broadly, without descending, between the antennae, where it is well rounded transversely; lower border broadly rounded. Vertex very low but slightly tumid, nearly or quite twice as broad as long, its sides a little raised and straight, its posterior border very slightly concave; its anterior border not descending. Eyes rather large and full, naked. Antennae inserted slightly in advance of the middle of the front, in perfectly distinct, shallow pits, their interior bases separated by the width of the base of the antennae and their outer crowded against the eyes; considerably longer than the abdomen and composed of about forty-two joints, of which the last twelve to sixteen form a very gradually incrassated, elongated club, which is cylindrical, rather strongly compressed, two and a half times broader than the stalk and four or five times longer than broad, the last four joints included in the diminution of size, the apex being rather rapidly rounded and the apical joint conical, the minute tip slightly produced; beneath furnished with three rather distant, distinct carinae, which extend upon the stalk. Palpi exceedingly long, tapering, and, at least the apical half, rather slender, fully four times as long as the eye and directed forward in the plane of the body, the apical joint twice as long as the penultimate and clothed, besides the ordinary covering, with a few scaly hairs beneath, while the other joints are heavily furnished with long, suberect scales, particularly on the upper and under surface and beneath, with a fringe of long hairs.

Prothoracic lobes consisting of very small, uniformly appressed laminae about two and a half times broader than high. Patagia almost flat, moderately broad and rather long, scarcely three times as long as broad, the posterior portion (a little more than one-third) bent downward, rather slender, rounded at tip, the inner margin being broadly and rather regularly rounded, the outer margin bent rather abruptly.

Fore wings (43:5) more than half as long again as broad, the costal border regularly and broadly arched, terminating abruptly and angulated at the apex. Outer border of an irregular shape; just below the apex it is directed backward at a little more than a right angle; when it has passed the lower subcostal nervule it is suddenly bent directly toward the base at less than a right angle with the previous portion, forming over the subcostal area a large, broad, triangular, bluntly pointed tooth; the rest of the border is nearly straight, a little crenulate and directed toward the apex of the wing; the lower angle is well rounded and the inner margin is straight. First superior subcostal nervule arising just before the middle of the outer half of the upper margin of the

cell; the second a little before the apex of the cell; the third as far beyond the apex of the cell as from the fourth; and the latter at somewhat more than half way from the apex of cell to the outer margin; second inferior subcostal nervule arising two-fifths way down the cell; cell very nearly half as long as the wing and nearly three times as long as broad. Last median nervule connected, fully half as far beyond its base as that is from the base of the first nervule, with the vein closing the cell.

Hind wings with the costal border strongly arched just at the base, beyond straight; the outer border, as far as the middle subcostal nervule, slightly convex and bent at a very broad angle with the inner margin; from the lower subcostal nervule to the submedian straight but considerably crenulate and directed at very slightly more than a right angle with the initial portion, the part in the lower subcostal interspace dividing the angle between them and crenulate; lower angle a right angle, scarcely rounded; inner margin very prominent and angulated at the extreme base, beyond straight, the portion beyond the submedian guttered. Precostal nervule originating opposite the divarication of the costal and subcostal nervures, curving strongly outward. Second subcostal nervule arising more than half as far beyond the first as that is from the divarication of the costal and subcostal nervures; cell closed by a scarcely perceptible vein.

Fore legs very small, cylindrical, in the male clothed, not very thickly, with rather long, spreading hairs on both sides and above; tibiae less than half (σ) or nearly two-thirds (φ) the length of the hind tibiae, in the female furnished with spurs; tarsi a little shorter (σ) or one-fourth longer (φ) than the tibiae; either composed of a single, unarmed, undivided joint, the tip bluntly conical (σ); or perfectly formed, the first joint as long as the others together, the second and fifth equal and scarcely longer than the third, the fourth half the length of the fifth; furnished on either side and along the middle beneath, excepting on the last joint, with a row of rather long and slender, pretty frequent spines, the apical lateral ones a little longer than the others; the terminal joint furnished with claws, paronychial and pulvillus like the other legs, only smaller (φ). Middle tibiae scarcely so short as the hind tibiae, both furnished beneath with an apical pair of short, slender spurs, but no spines. First joint of tarsi fully equalling the succeeding three together, the second and third about equal and scarcely so long as the fifth, furnished beneath with four rows of not very long, slender, nearly recumbent, crowded spines, the apical ones a little longer than the others on each joint. Claws very small, short, rather stout, tapering, the apical half strongly curved, the tip bluntly pointed; paronychial double, the superior lobe scarcely so long as the claws, slender, tapering, a little curved, bluntly pointed; the inferior lobe nearly as long as the other, slender, nearly equal, bluntly pointed, straight; pulvillus minute, almost transversely linear, the anterior edge broadly rounded.

Eighth abdominal segment of the male laterally angulate and produced in the middle into a tapering, hook-shaped process, the tip of which (with its long apical tuft of bristles making it of much greater apparent length) is usually concealed by the clasps, and, with them, conceals the acicular and very slender upper organ, which passes between a pair of tapering, acicular hooks depending from the base of the outer edge of the produced tip of the upper organ. Clasps simple, lamellate, entire, uniformly compressed, about twice as long as broad, directed upward and backward.

Egg. With no constriction below the tip, about two-thirds as broad as high. Vertical ribs increasing considerably in height upward, where they terminate abruptly, as in *Polygonia*, leaving a similar depressed summit.

Mature caterpillar. Body very slender, enlarged at the thoracic joints, with the dorsum of the last abdominal segments subdepressed; a blunt, supralateral?, anterior tubercle on either side of the middle thoracic segment.

Chrysalis. Head a little excised apically, separating two slight, lateral prominences; abdomen beyond the base elevated dorsally to a height nearly equal to that of the mesonotum.

Distribution. This is a strictly American genus found mostly in the

subtropical region on the Atlantic side of the continents, north of the equator. One species occurs in northern South America, two others in the Antilles and Central America, a fourth is known only from the Mexican border of the United States, and is probably Mexican, while the northernmost inhabits the United States, and especially its southern portion, but has been found in two or three instances in New England and its neighborhood. The species of the genus therefore appear to stretch in belts from the equator to Latitude 45° N.

Characteristics. The butterflies are rather below the medium size but are very striking in appearance; the palpi are considerably more than half as long as the whole body, the wings are very strongly angulated, the fore pair especially strongly excised just below the lowest subcostal nervule. They are dark brown above, the hind wings furnished with a broad, fulvous patch across the middle, the fore wings with similar but longitudinal patches, one in the cell and the other following the lower median nervule; in the apical half of the same wing are three white spots forming a large triangle. Beneath, nearly the whole basal half of the fore wings is fulvous, and the rest dark brown with a repetition of the white spots; the hind wings beneath are of changing shades of brown, speckled with blackish, and often varied with metallic tints.

The butterflies are probably polygonentic, and hibernate in the imago state. The larva is cylindrical, slender, naked, green, with lighter or darker dorsal and lateral stripes. The chrysalis is well rounded, the head not produced but angulate, the dorsum of thorax and abdomen considerably arched with a rather strong constriction between; it is green with some inconspicuous, pale yellow, longitudinal stripes, following the carinate parts of the body.

Relationships. The genus is the only one of its subfamily found on this continent, and the species have been universally regarded by naturalists as congeneric with those of the Old World. This appears to be merely the result of their all belonging to a remarkable and isolated type of butterflies and not to any careful study of their structure. I have not been able to study the Asiatic species, but the European and African are certainly distinct from the American forms. I would call attention to the abruptly lobate front margin of the hind wing in the European species (*Libythea* proper), and the close approximation of the third and fourth superior subcostal nervules of the fore wings at their origin, to the gradually incrassating antennae, in which the club can scarcely be separately distinguished, but may be said to occupy half the length of the antennae, to the coarser and, owing to the comparative brevity of the apical joint, the somewhat shorter palpi, and finally to the deeply bifid termination of the eighth abdominal segment in the male, with the irregular and thorny clasps, which are in striking contrast to those of *Hypatus*. It may also be

pointed out that the larvae of *Libythea* are not thickened on the thoracic segments, have no thoracic tubercle and that the chrysalis terminates at the anterior extremity in a single and not a double protuberance: in other words there is no apical notch.

EXCURSUS XXIV.—FOSSIL BUTTERFLIES.

And many an antenatal tomb,
Where butterflies dream of the life to come,
She left clinging round the smooth and dark
Edge of the odorous cedar bark.

SHELLEY.—*The Sensitive Plant.*

FOSSIL butterflies are the greatest of rarities. They occur only in tertiary deposits, and out of the myriads of objects that have been exhumed from these beds in Europe and America, less than a dozen and a half specimens have been found. The great body of these deposits, as is well known, are of marine origin, but at least thirty thousand specimens of insects have been recovered from those beds which are not marine. Over fifteen thousand insects from the one small ancient lake of Florissant, high up in the Colorado Parks, have passed through my hands, yet I have seen from there but seven butterflies. Each of these belongs to a genus distinct from the others, as is also the case with all, or all but one, of the butterflies found at Radoboj, at Aix and at Rott in the European tertiaries. With two (European) exceptions, each represents an extinct genus, and these two exceptions, *Eugonia* and *Pontia*, are genera found today both in Europe and America. The species, however, are all extinct.

One would hardly anticipate that creatures so delicate as butterflies could be preserved in a recognizable state in deposits of hardened mud and clay. Yet not only is this the case, but they are generally preserved in such fair condition that the course of the nervures and the color-pattern of the wings can be determined, and even, in one case, the scales may be studied. They are as a rule so well preserved that we may feel nearly as confident concerning their affinities with those now living, as if we had pinned specimens to examine; and generally speaking the older they are the better they are preserved!

There is, however, no great difference in their age. Aix and Florissant are probably both oligocene and in any case can differ but slightly in age; one of the butterflies from Aix, *Coliates*, comes from beds a little lower than the others and may be looked upon as probably the oldest butterfly known. These two oligocene localities share between them a dozen butterflies, not to mention a caterpillar from Aix which has been considered that of a butterfly. Rott, the next oldest (lower miocene) has furnished only one butterfly; and Radoboj (middle miocene) the remaining three.

Three of the four families of butterflies are represented in this meagre little collection, the smaller butterflies of the family *Lycaenidae* being unknown in a fossil state in the rocks, though it is rather vaguely reported that they have been found in amber. The largest number (9) are *Nymphalidae*, the next (4) *Papilionidae*, while the *Hesperiidae* have only two representatives. All but one of the seven American species, however, belong to the *Nymphalidae*; that exception to the *Papilionidae*.

These meagre statistics may have a certain interest; but it is of more importance to inquire how far the fossils differ from existing forms, and what they teach us. For this purpose let us examine the European and American forms separately, and turn our attention first to the nine European species, omitting the caterpillar from Aix which is thought to be one of the *Satyrinae*, to which subfamily two of the five Aix specimens belong. All these European forms have been subjected to a severe analysis.

To begin with the highest and pass downward, we have first two *Satyrids*, a group now represented by the dark brown butterflies of our meadows; the nearest allies of both of these, *Neorinopis* and *Lethites*, are now restricted to the Indo-Malayan region, and are much more gaily attired than the present sombre representatives of the subfamily in Europe. Their food in the larval state has invariably been found to be either grasses, or, occasionally, with the more arctic or alpine forms, sedges. In the Aix deposits, as in the Indo-Malayan region to-day, these plants are numerically unimportant, so that if we may form any opinion from such meagre data, we find that while oligocene Aix had a European proportion of *Satyrids*, they were composed of species of an Indian aspect and fed upon plants characteristically temperate, but, as in tropical countries, numerically unimportant.

The remaining *Nymphalid* is the *Eugonia* from Radoboj. This is more nearly related than any other to the mass of the Florissant fossils. It belongs to an existing genus represented to-day equally in Europe and America, but with a fuller development of neighboring genera in the New World, showing that its affinities are with the New rather than with the Old World; its food in early life was probably some species of elm, willow, poplar or birch, and species of all these genera have been found in the same beds.

Passing to the *Papilionidae* we find three *Pierinae* and one *Parnassian*; two of the three *Pierinae* are allies of our common brimstone yellow butterflies, and the third to our white spotted cabbage butterflies. The former, however, *Mylothrites* and *Coliates*, belong to distinctly tropical types, referable again to the Indo-Malayan or Austro-Malayan regions; their larvae doubtless fed on leguminous plants, which have been found in abundance both at Aix and Radoboj from which these species come. The white butterfly belongs to the existing genus *Pontia*, whose present geo-

graphical relations are almost precisely those of *Eugonia* mentioned above, though the genus itself is far better represented today in Europe than in America. They feed generally on *Cruciferae*, but these are plants of a nature hardly admitting of preservation in a fossil state and are excessively rare in the European tertiaries; none have been found at Radoboj whence this butterfly comes, the most closely allied being a species of *Terminalia*. The Parnassian is an interesting insect, belonging to a striking and rather aberrant group. From its affinities to *Thais* it is called *Thaites*. *Thais* is confined to-day to the Mediterranean district, within which Aix, its place of deposit, belongs, and its allies are found, some in the same region, some in China and Australia, and some in Alpine regions. It probably fed on *Aristolochia* and while this genus has not yet been found at Aix, it is found in other European tertiary deposits, and according to the Marquis Saporta, the principal student of the fossil plants of Aix, "ce genre devait y exister." When compared with *Thais*, the markings of *Thaites* are seen to show an inferior character, indicating a clearly earlier type.

There are left the two *Hesperidae*,—a family not represented in American rocks. One of these, *Thanatites* from Rott, belongs to the tribe *Hesperidi*, and is closely related to *Thanaos*, a genus found in the north temperate zones of both hemispheres, but vastly more developed in the New World, which has at least four times as many species as the Old, some of them extending into the subtropical regions; the adjacent genera are purely American, although tropical or subtropical, and therefore *Thanatites* looks toward subtropical North America for its prevailing affinities. Entirely the same is the case with *Pamphilites* of Aix, a butterfly belonging to the other tribe of *Hesperidae*. The food plant of both these butterflies was very probably *Leguminosae*, which occur in abundance both at Rott and at Aix.

The allies, therefore, of nearly one-half of the European fossil butterflies are to be looked for in the East Indies; of one-third of them in America, and especially subtropical America; of the remainder at home; but, as among other insects and among the plants, there is growing likeness to American types as we pass upward through the tertiaries.

The American fossil butterflies, fewer in number, less varied in character, and all from one locality are more quickly reviewed. They all belong to extinct genera. Six of the seven belong to the *Nymphalidae*, and all but one of them to a single tribe, *Vanessidi*, of the subfamily *Nymphalinae*. Of these, three, *Prodryas*, *Jupiteria* and *Lithopsyche*, form a group by themselves, more closely allied to one another than to any living forms, but having distinct affinities to certain butterflies of Central and generally subtropical America. A fourth, *Nymphalites*, is related to them, though not very closely, and it, too, finds closer relations among Central American butterflies. The fifth, *Apanthesis*, is still farther removed and is related,

as closely as to anything, to a tropical American group of butterflies geographically isolated, all of its immediate relations being East Indian. Of none of the butterflies to which all of these Nymphalinae are allied is the food plant of the caterpillar known.

The sixth Nymphalid, *Prolibythea*, is of special interest, for it belongs to the curious subfamily *Libytheinae* of which only a dozen species are known. No group of butterflies exists with so many anomalies of structure; none, so far removed from its nearest neighbors, which is anywhere nearly so poverty-stricken in forms. It is a clear case of a waning type; and that out of the paltry dozen or two of fossil butterflies one should be found to belong to a type which cannot number more than a tenth of one per cent of living forms is indeed a surprise. It has a further interest, for the existing Old World forms of this group and those of the New are separated by characters which are unmistakably combined in this fossil, though on the whole the relations of the fossil are rather with the Old World than with the New World type, and especially with a form from Western Africa. The group as a whole is distinctly tropical and subtropical and wide spread, so that the subtropical aspect of the previously known *Florissant* forms is not disturbed. The food of the larva, so far as known, is exclusively *Celtis*, and it is interesting to note that Lesquereux has found among the plants of *Florissant*, in the same beds with *Prolibythea*, two perfectly well preserved leaves of a very fine *Celtis*, whose generic relations are positively ascertained; with them were also found fragments of flowers which could have been readily admitted as of the same species. It is therefore highly probable that *Prolibythea vagabunda* fed on *Celtis maccoschi* Lesq.

The last American fossil is *Stolopsyche*, one of the *Pieridi*, more nearly allied to *Pieris* proper, including our New England species, *P. oleracea* and the imported *P. rapae*, than to any others; it is not very nearly related, and wherein it departs from these it comes nearer to some subtropical forms. Little, however, can be said concerning it, and nothing of its probable food plant can safely be surmised.

The aspect of the *Florissant* butterfly fauna is therefore distinctly southern; and while tertiary America does not fully return the compliment tertiary Europe seems to pay it, there is a certain Old World aspect in the representative of that gypsy-type, the *Libytheinae*.

There are one or two points further in our American fossil butterflies which it is interesting to note. In two or three of them the structure of the front legs can be determined and we are able to note that in this oligocene time, among the earliest butterflies that have come down to us, we have the same structure of the female fore leg in *Libytheinae* that we have to-day. As this is one of the present stumbling blocks of the systematist it is well to draw attention to it. The more particularly, as the

atrophy of the male fore legs is shown to have reached, in *Nymphalites*, the same stage which it now possesses.

On the other hand, there are some marks of a lesser degree of development in one of our butterflies, in the character of the ornamentation, similar to, but more distinct than, that we have mentioned in one of the Aix butterflies. *Prodryas* (16:6) has front wings which in form, proportions, and markings would be taken at once for those of an *Hesperian*, the lowest, rather than of a *Nymphalid*, the highest of butterflies; the markings of the hind wings are, however, distinctly *Nymphalideous*, though some tropical American *Hesperiidae* have some features nearly resembling them. A greater simplicity of markings than is common to their existing relatives is also seen in *Neorinopsis* and *Apanthesis*.

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HYPATUS BACHMANII.—The snout butterfly.

[The snout butterfly (Gosse); red and black beaked butterfly (Maynard).]

Libythea bachmanii Kirtl., Amer. journ. sc., (2), xiii: 336-337, fig. (1852); Proc. Clevel. acad., 1845-59, 171 (1874);—Morr., Syn. Lep. N. A., 63-64 (1862);—Saund., Can. ent. i: 25, fig. (1868); Rep. ent. soc. Ont., 1880. 38, fig. (1881);—Edw., Butt. N. A., ii, pl. *Libythea* i (1874); Can. ent., xiii: 226-229 (1881); Rev. cat. diurn. Lep. Am., 51 (1885);—Streck., Syn. cat. macrolep., 105 (1878);—French, Rep. ins. Ill., vii: 157 (1878); Butt. east. U. S., 250-252 (1886);—Mayn., Butt. N. E., 31, pl. 8, figs. 36, 33a (1886).

Hypatus bachmanii Scudd., Bull. Buff. soc. nat. sc., ii: 269 (1875).

Libythea motya Boisdu-BeC., Lép. Am. sept., pl. 64, figs. 3, 4 (not figs. 1, 2) (1833).

Libythea motya, var. *a. L. bachmanii* Kirby, Syn. cat. diurn. Lep., 283 (1871).

Papilio carinenta Abb., Draw. ins. Ga. Brit. Mus., vi: 40, figs. 32-33 (ca 1800).

Figured by Glover, Ill. N. A. Lep., pl. 25, fig. 11; pl. V, fig. 11, ined.

[Not *Hecarge* *motya* Hübn., nor *Papilio carinenta* Cram.]

Therein two deadly weapons fixt he bore,
 Strongly outlaunced towards either side,
 Like two sharpe speares, his enemies to gore:
 Like as a warlike brigandine, applyde
 To fight, layes forth her threatfull pikes afore,
 The engines which in them sad death doo hyde:
 So did this Flie outstretch his fearefull hornes,
 Yet so as him their terrour more adorne.

SPENSER.—*Muipotmos*.

Imago (4:4). Head covered with mouse brown scales and pretty long hairs, mingled, above with a few, behind at the sides, with frequent hoary ones. Eyes rich, dark, reddish brown, edged with an exceedingly slender, hoary rim most distinct in front. Antennae dark, dull purplish brown, with a scarcely perceptible lustre, beneath tinged with russet, the joints on the basal half of the stem tipped with dirty white, most conspicuously and broadly beneath, the paler colors sometimes suffusing nearly the whole joint, above obscurely, and sometimes not at all, except toward the sides; club beneath, and three or four apical joints above blackish, the apical joint tinged with russet. Palpi above covered with uniformly long, mouse brown hairs with a few scattered hoary and very

dull, tawny ones, especially along the inner half; at the sides and below gray, with a mixture of whitish and dull, tawny brown scales and hairs, the former more profuse near the base; the second joint is also furnished with distant, rather longer, delicate blackish hairs, above as well as below, which are entirely wanting on the apical joint. Tongue very dark luteous at the base, beyond black, the tip luteous.

Prothorax like the top of the head; rest of thorax with long hairs, dark brown in front, pale brown along the sides and brownish mingled with light sea-green above; patagia like the thorax. Under surface of thorax covered with pale brown scales, having a rosaceous tinge and with hoary, brownish and a few blackish hairs. Legs reddish or yellowish brown, the femora covered thickly with hoary hairs, the tibiae and first tarsal joint flecked with frequent whitish scales, the tarsal joints tipped with whitish; spines blackish; spurs yellowish brown at base, beyond black.

Wings above blackish brown of various tints marked with orange patches and white spots. *Fore wings* with two large orange patches, one, occupying the hinder half of the cell, obscure next the base, extending forward a little in the middle of the anterior half, the other large, subquadrate, divided by the black, lower median nervule, occupying the lower two-thirds of the lower median, and the whole of the medio-submedian interspaces between the origin of the lower median nervule and a point nearly two-thirds the distance from its origin to its tip; it is separated from the orange patch in the cell only by the median nervule. In the apical half of the wing are the following white markings: a transverse patch extending from close to the costal margin to the upper median nervule, its interior margin straight or nearly so, distant beyond the extremity of the cell by fully the width of the white patch, directed downward at an angle of about 100° with the basal half of the costal margin; the outer margin of the patch is curved, its convexity outward and strongest below; in the lower subcostal interspace the patch is twice as broad as the width of the interspace; the two lower nervules which traverse the patch and the edge of that portion of the patch are reddish yellow, those above blackish. There is a squarish, slightly longitudinal spot in the next to the lowest subcostal interspace just beyond the last divarication of the subcostal, and a similar quadrate, transverse patch in the upper median interspace, distant from the outer border by rather more than its own width; the lower spot is edged with reddish yellow and bears a few scattered scales of the same color; the apical half of the costal edge is enlivened by a few grayish scales, which are sometimes more distinct in a delicate touch at the very apex; rest of the wing very dark, rich brown, with an olivaceous tinge, deepening into black in a broad, transverse belt between the orange patches and the outer subcostal white spot. Fringe russet brown, darkest at base, interrupted rather broadly at some of the nervule tips and especially at the two upper median nervules with pale or whitish. *Hind wings* quite dark, somewhat slaty brown, paler along the inner border, slightly deepening in tint along a scarcely distinguishable longitudinal belt following the lower part of the subcostal nervule. A large, transverse, orange patch occurs just beyond the middle of the wing, deepest in tint and distinctly bordered anteriorly, extending from the middle subcostal to the lower median nervule, twice as long as broad, its lower border nearly straight and subparallel to the outer border, but more distant from it toward the inner border, its upper limit reaching the last divarication of the median nervule and in the subcosto-median interspace sending a slight shoot toward the base. Fringe pale yellowish brown, on the lower half with a russet tinge, darkest at the nervule tips, apically palest.

Beneath: *fore wings* with the whole costal border rather dark gray, the cell dull orange, the inner margin steel gray, the base of the medio-submedian interspace, two-thirds the distance to the base of the first median nervule, dark brown, beyond, as far as the middle of the nervule, dull pale orange, separated narrowly by brownish nervures from the orange spot in the cell and from one at the base of the lower median interspace; the latter, also pale, reaches as far toward the margin as it, but does not attain the upper limits of the interspace; beyond the large orange patch thus formed, the lower outer corner of the wing is lustrous steel gray. The white spots of the

upper surface are repeated beneath and bordered as there, but the outer subcostal spot is faint, and the nervures are also white, excepting one in the upper part of the oblique row of spots. This row lies in a blackish brown field, with a greenish tinge, which extends within and below to the orange patch, and without to the inner limits of the white spots; at the upper apex of the wing, between this black field and a line from the apex of the wing toward the middle of the median white spot, the wing is minutely and delicately mottled with silvery-, nacreous- and greenish-gray and dark brownish, giving it a hoary gray appearance, while beyond it the falcation is dark lustrous brown, enlivened by obscure paler tints. Sometimes the whole apex of the wing is almost uniformly steel gray, occasionally with a lilac tinge. flecked obscurely and minutely with blackish. Fringe as above. *Hind wings* in certain lights uniformly lustrous, pale gray brown, the median nervure blackish (δ), or uniformly rather dark gray brown, with a lustrous violaceo-purplish hue (♀). In other lights the wing is covered with a gray mottling of silvery gray scales, often tinged with pale nacreous, rosaceous and greenish, excepting in three very large, dark lustrous brown patches, deepening about the nervures into purplish black; these patches are situated: one on the costal margin, removed by its own width from the base, its outline on the wing semi-elliptic, extending to the middle of the cell just within the first divarication of the subcostal; a second crosses most of the wing in a line subparallel to the outer margin, its outer border extending from the tip of the costal to the middle of the submedian nervures, of irregular breadth, but extending to the base of the wing along the median nervure; the last occupies the outer border in a very broad band, nearly twice the width of an interspace, the inner border of which extends in a broad, flattened arch from the tip of the middle subcostal nervule to the tip of the submedian nervure; sometimes this outer patch is broader, and includes next the outer border a paler portion; and it is sometimes quite indistinct; in other lights these darker patches have a pale green sheen, and the inner border a pale lilac or rosaceous tinge. The wings, and particularly the grayish parts, are furnished with scattered, infrequent, black dots; one larger and more marked than the rest occurs in the subcosto-median interspace, just above the bend of the upper median nervule. Fringe as above.

Abdomen dark brown above, with a good many lustrous reddish brown scales, and on the basal joints a few greenish hairs; beneath silvery gray. Median hook of eighth abdominal segment of δ (34: 12, 13) very slender and finely pointed; depending lateral hooks of the same a little recurved, scarcely so long as the median hook, and scarcely slenderer than the latter when viewed laterally; upper organ a little surpassing the median hook above; clasps pretty regularly ovate.

Measurements in millimetres. Length of tongue, 6.5-7 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....		23.			23.75	
antennae.....		9.75			9.85	
hind tibiae and tarsi..		5.75			5.85	
fore tibiae and tarsi..		2.5			3.75	

Secondary sexual characteristics. On the upper surface of the fore wing of the male I discovered untoothed scales (46: 16), very sparingly distributed, which could not be found in the females, and which I consequently regard as androconia. Their close resemblance to the similarly scanty presumed androconia of *Charidryas* on one side and *Calephelis* on the other will be noted. They are profusely striate, enlarged slightly from the base outward, with straight sides, truncate tip, roundly bent outer angles, and well rounded and moderately large basal lobes.

Egg (64: 42). Largest below the middle, with eighteen to twenty narrow, compressed and prominent vertical ribs, the course of which is not always straight throughout, all of which originate below, just above the rapidly narrowing base, and most of which terminate abruptly a little below the truncate summit, while above their termination the eight which continue are much elevated, laminate, and terminate abruptly at the micro-

pyle rosette. The interspaces and the ribs themselves are crossed by numerous horizontal raised lines, thus forming transverse rectangular pits between, about three times or more as broad as high. At the base of the egg the ribs and cross bars, here of equal prominence, become broken up into an irregular mesh like the cap of a thimble. At the summit, the circle within the termination of the ribs is .08 mm. in diameter; the quadrangular cells, which here are only twice as broad as high, become, within the circle, rounded polygonal cells, with a diameter of .017 mm. The micro-pyle rosette is therefore made up of a very few rather large cells, the walls of which toward the centre become nearly obliterated. Color very pale green. Height of egg, .7 mm.; breadth, .45 mm.; greatest elevation of ribs, .05 mm.; height of rectangular cells, .017 mm.; greatest distance apart of vertical ribs, .065 mm. From specimens received from Mr. Edwards.

Caterpillar. *First stage.* "Cylindrical, the segments a little rounded, and four times creased transversely, covered with a fine short down ['with fine hairs']; color green, semitranslucent ['greenish brown translucent']. Head twice as broad as [first thoracic segment], obovoid, a little depressed at [median] suture, the vertices rounded, sparsely pilose, color yellow brown" (Edwards). Length, 1-1.5 mm.

Second stage. "Color brownish green, the segments curved. Head a little broader than [the segment behind it], shape as before, color yellow green" (Edwards). Length, 2-2.25 mm.

Third stage. "Same shape; upper side dark green; a faint shade of yellow over and along basal ridge, rather macular; under side, legs and feet lighter green; the segments much specked with faint white on the ridges caused by the creases; on [middle thoracic segment], high up, a black dot on either side. Head as before, color light green" (Edwards). Length, 3 mm.

Fourth stage. "Color dull green, yellowish along and over basal ridge, specked with pale white or yellow white as before, the black dots as before. Head green" (Edwards). Length, 6.5-7 mm.

Fifth stage (75:19). "Cylindrical, thickened at [the last two thoracic segments], the dorsum of last [abdominal] segment abruptly curved down to the end; color dark green, the lower side, and also feet and legs, pale green; each segment four times creased transversely, and on the flat ridges so caused are rows, one to each, of small, tubercular, flattened points, pale or whitish yellow; [on all the segments of the body] a white stripe along base, just over the spiracles, and above this the ground is yellowish for a little way; a mediodorsal yellow line and sometimes a fine line on middle of side; yellow, tuberculated points over the legs, in arcs from [middle thoracic to second abdominal segment]; on foremost ridge of [middle thoracic segment], high on the side, a dead black tubercle, a little raised and rounded, in yellow ring; spiracles in brown ovals; surface covered with a fine short down. Head obovoid, green, smooth, sparsely pilose; the ocelli brown" (Edwards). Length, 18-23 mm.

"Occasionally the larvae in later stages are differently colored. One had the dorsum dark green, edged on either side by a gray line, and successively by a band of yellow, a gray line and a black band; the [middle thoracic] segment was wholly, and [the first abdominal] partly black. Two others of same brood were green, and black patches on" middle thoracic and seventh abdominal segments (Edwards).

Chrysalis (84:23, 24). "Helmet shaped, compressed, the abdomen somewhat carinated [dorsally]; mesonotum high, rounded, sloping abruptly to top of head-case, much compressed and sharply carinated, followed by a deep excavation [between thorax and abdomen]; head-case not prominent, square or nearly so at top, a little excavated, the corners subpyramidal and scarcely at all produced; along carina of abdomen a yellow line, which forks and passes round mesonotum to top of head-case; a slight, yellow, lateral line on abdomen. Color green, either deep or with a blue or a yellow tint; the abdomen much sprinkled with pale yellow flat points or small spots, a few of these about the head-case" (Edwards). Length, 12.7 mm.

I have examined in Boisduval's collection the butterfly figured in Boisdu-

val and Le Conte's work on North American butterflies, under the name of *Libythea motya*, and it is the West Indian species, *Hypatus terena* (Godart), the occurrence of which in the United States is unknown; the caterpillar and chrysalis, however, are from Abbot's drawings, and represent our common species. *H. bachmanii* was also in Boisduval's collection, separated from the other, but without name.

Distribution (21:8). Properly speaking, this butterfly appears to be a member of the Carolinian fauna, although it has been found occasionally (and sometimes in great numbers) in the Alleghanian fauna. The localities from which it is recorded are so distant and extend over so wide a territory that one may reasonably suppose it to be local in its distribution; the more so, since it seems to be very variable in its appearance; "once common, now rather rare," says Dr. Hoy of Racine, Wisc.; "rare formerly, but common in 1875," according to Professor Snow of Kansas. Southwardly it is found in the Gulf States,—Apalachicola, Florida (Chapman), Alabama (Gosse, Grote), central and southern Texas (Belfrage, Aaron); west of the Appalachian chain it occurs in both northern and southern Ohio (Kirtland and British Museum), in northern and southern Illinois (Worthington, Walsh), in eastern Kansas (Snow), and even in Virginia (Doll). It has been observed in several of the Atlantic states,—Georgia "rare" (Abbot), West Virginia, a few individuals every season (Edwards), southern Maryland (Uhler), Philadelphia, Pa., "rare" (Blake), Hoboken, N. J., one specimen (Andrews) and Long Island, N. Y., once taken (Grote); and to the north, besides the New England localities, it is recorded in one or two instances from the warmer parts of Ontario, as Port Stanley (Denton), Hamilton (Miss Mills).

Dr. T. W. Harris wrote to Dr. Kirtland many years ago: "I took [it] in my little garden on the 24th of June, 1849, the only specimen I have seen here" at Cambridge, and to this day this is the only specimen known from Massachusetts. It is also reported to have been once taken at New Haven, Conn.; but still more extraordinary are two specimens noticed by Mr. F. G. Sanborn in the collection of Dr. F. F. Hodgman of Littleton, N. H., to the north of the White Mountains, which were captured in that vicinity in roads through the woods. It may, therefore, be looked on as a possible inhabitant of almost any part of New England, though of excessive rarity.

Haunts. In Alabama, according to Grote, it is found on river banks and about damp places on roads; and Walsh wrote Edwards that he found it "in swarms along the travelled road" in Jonesborough, Ill. Dr. Hoy told Dr. Kirtland that when the common raspberry was in flower it was a common resort of the butterfly at Racine, so that the butterfly may be set down as a probable frequenter of roadsides. Abbot, however, says that they frequent blossoms in fields adjoining swamps; and Wallace reports the Amazonian species as "flying about marshy meadows in the sunshine."

Food plants. Dr. Kirtland conjectured that raspberry might be the food plant of the larva, but Abbot long ago found it feeding on the sugarberry or hackberry, *Celtis occidentalis* L., one of the *Urticaceae*; and Boisduval and LeConte figure it on that plant. It would seem as if Major LeConte knew of its food plant either from Abbot or by his own observations, for, in the original drawings Dr. Boisduval showed me, no plant whatever is drawn or specified. Edwards, who alone in recent years has raised it, says that he is not aware that it has any other food plant; but *Celtis* does not grow so far north as some of the localities where the butterfly has been found, notably northern New Hampshire.

Life history. Our knowledge of the history of this butterfly is rather imperfect; our best information comes from Mr. W. H. Edwards, who says: "It is certain that in this region (W. Va.) the species appears in several successive generations, probably four, that the later butterflies hibernate, and the survivors are on the wing early in May, and probably in favorable seasons, in April. The first generation in descent from the hibernating females are on the wing in June,—the second generation in July,—the third in August, and late butterflies emerge from chrysalis in September, and these would be of the fourth generation in descent from the hibernating females. The period from laying of the egg to emergence of the butterfly is from fifteen to seventeen days." In confirmation of this he reports a capture of a worn female before the middle of May, and gives the dates of his captures of all stages for ten years, by which it appears that there is hardly a week in the year from the end of the first week of June to the same part of September that eggs have not been found or they may be inferred as existing, from the discovery of caterpillars a little later. Data from other sources are scarce. Dr. Harris's specimen was taken in Cambridge on June 24. Gosse records one capture in Alabama on July 15; Andrews took his at Hoboken September 2; Miss Mills that at Hamilton early in August. Dr. Hoy says that it appears in Wisconsin while the raspberry is in flower; Grote that it is found in Alabama in July and August; while Dr. Chapman states that he took two "rather old" specimens in Florida in February. This latter statement and Abbot's record of caterpillars changing to chrysalis on the 29th of April and appearing as butterflies in nine days verify Edwards's belief that the imago hibernates. For other points in the history of this insect we shall borrow bodily from Mr. Edwards:—

The eggs [are] laid singly on the immature leaves at extreme ends of the branches, and I found . . . that nearly every branch had its egg. . . . Usually one egg is laid at the end of a branch, in one of the forks, on the leaf-stem, but I have seen two eggs on the same stem, and occasionally an egg laid on the under side and middle of a leaf. [The duration of the egg is only four days.]

Several of the eggs hatched in the glass to which I transferred them. But the larvae were exceedingly delicate, and one after another dropped off the leaves till all

were dead. . . . But I was able to replenish the stock from the tree when the larvae had become a few days old, and thenceforward had no difficulty whatever. . . . The young larvae on hatching. . . eat their way out of the egg a little below the tip but do not eat the egg shell after emerging, and the empty shell has often guided me to the whereabouts of the young caterpillar. . . . On hatching they ascend to the extremity of one of the leaves and remain there, stripping the sides, leaving the midrib untouched, whence it is easy to find them.

When about half grown, the larvae in confinement might be seen slowly making their way up the side of the glass, by means of a zigzag ladder which they spun as they went, and the glass became well coated with this kind of web. After the fourth moult, they began to fasten the leaves loosely together, and stretched several threads across the top of the glass. These threads were quite strong enough singly to bear the weight of a caterpillar, and I have seen one cross the diameter of the glass in this way, walking feet upward; in this case the traveller proceeded cautiously, stopping several times and throwing a thread to the right or left by a corresponding movement of its head, whereby to attach its unsteady bridge to a neighboring line or leaf.

There is something in their attitude when at rest that distinguishes them from other butterfly larvae. For hours they remain with the head and upper segments thrown back and arched, after the manner of the typical Sphingidae. Or the anterior segments are raised from the leaf and curved forward, the [first and second thoracic] and posterior segments being swollen, and the middle ones flattened dorsally, an odd habit I have not observed in any other species. . . . I have noticed another remarkable peculiarity in these larvae. On 30th August, I returned home after an absence of but three days, and found the leaves that I had placed in the glass with four larvae, which had just passed their third moult at my departure, dried up and all the larvae changed to chrysalids, thus crowding into less than three days changes which naturally require six. The chrysalids were not more than half the usual size, and the butterflies that came from them were small and pale colored.

A similar result followed on sending specimens which had just completed their third moult on a two days journey; once the larva "had fixed for chrysalis and in the other had actually changed," although their food was still fresh. The chrysalis hangs "five days in July, seven in August."

Desiderata. The most important points requiring elucidation in this butterfly are the satisfactory determination of how many broods there are each year, the rearing of considerable numbers toward the latter part of the season, to determine whether it passes the winter in any other state than as a butterfly; and the reason for its erratic distribution and variable abundance. The question of the affinities of this remarkable type being an important one, especially in view of its antiquity, it is highly desirable that a most minute account be given of the internal and external anatomy of the earlier stages.

LIST OF ILLUSTRATIONS.—*HYPATUS BACHMANII*.

<i>General.</i>	<i>Imago.</i>
Pl. 21, fig. 8. Distribution in North America.	Pl. 4, fig. 4. Male, both surfaces.
<i>Egg.</i>	34: 12, 13. Male abdominal appendages.
Pl. 64, fig. 42. Colored.	39: 5. Neuration.
<i>Caterpillar.</i>	46: 16. Androconium.
Pl. 75, fig. 19. Mature caterpillar.	54: 6. Side view of head and appendages
<i>Chrysalis.</i>	enlarged, with details of the structure of the legs.
Pl. 84, fig. 23, 24. Side views.	